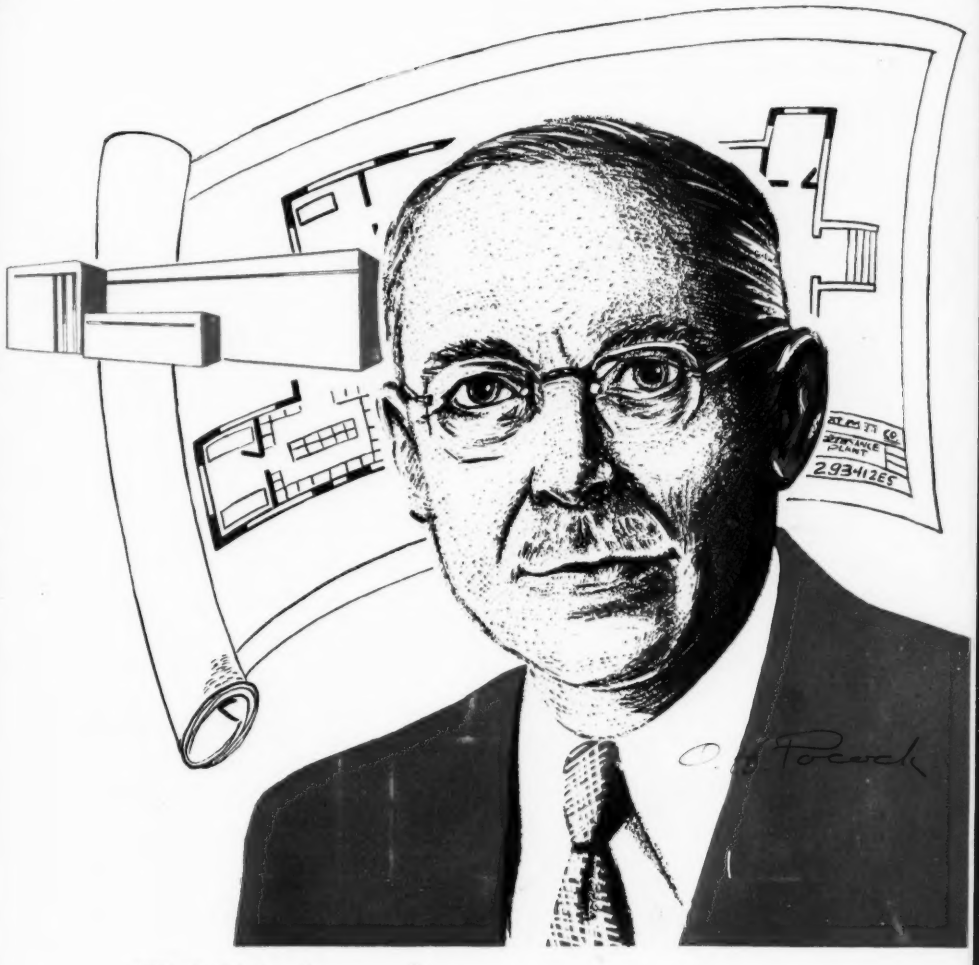
consulting engineer

April 1953



"His habit is silence . . ."

Prime Mover of Projects

Oscar H. Pocock has been chief engineer of Giffels & Vallet, Inc., L. Rossetti since 1927, and his knack for "moving" a job is a major factor in the growth of that firm.

Personally, he is a sociable fellow, modest about his accomplishments. He seldom refers to the design and engineering feat

(Continued on page 8)

a new miniature indicator!

Available with:

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PNEUMATIC TRANSMISSION

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easy to read—5 inch scale, no parallax

easy correlation of related functions

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HAYS Miniscale Gages

This miniature instrument is especially suited for remote indication of such variables as pressure, draft, flow or level.

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Also available is the Hays direct reading miniscale gage for indicating *pressures* of fluids (steam, water, gas, oil, etc.) directly.

Gages are arranged for flush or semi-flush mounting. Either a yoke mounting, for as many as 12 units, or a keyhole clamp mounting for individual units can be provided.

Write today for full information on the Hays Miniscale Gages Bulletin 52-1075-223.

Automatic Combustion Control
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Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 32, INDIANA

VOLUME 2
NUMBER 2

consulting engineer

APRIL 1953

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Very Truly Yours

THE OTHER DAY I went around on the other side of my desk to look at the March issue of CONSULTING ENGINEER from your viewpoint—the viewpoint of the reader. And here's the thought I had. If I were a consulting engineer, I'd be a little hesitant to write to this magazine for help with just any kind of problem. I might ask for an opinion, for example, but I would hesitate to ask the editors to get their hands dirty for me.

I think what made me feel that way is that CONSULTING ENGINEER is so highly polished, well-groomed, and obviousy dressed in its Sunday best. Now let me get back into my chair and tell you how we, the publishers and editors, feel about all this.

Sure we've fixed up CE to look just as handsome as we know how. We did that because consulting engineers are very important people—they're professional men and that means dignity, quality, and position. Much of CONSULTING ENGINEER's benefit for you will be to enhance and extend your professional standing. We had a selfish motive, too. We want you to be proud of this magazine that bears the name of your profession, and we know we can compete more effectively for your reading time with a handsome, high-quality magazine.

But it's equally important to us for you to know that our editors have their work clothes, too, and none of them is afraid to get his hands dirty.

Also, we don't have an editor who is too busy to stop his work and do something specially for you—no matter how much of a chore it may be.

Hunter Hughes, our editor, is extremely conscious of his service responsibility to each of you. That's one of his attributes that convinced me he'd make the "working" kind of an editor we wanted. For example, when Hughes was making up the Book Department for the March issue, he came to me with the idea of making this column as easy as possible for you to use.

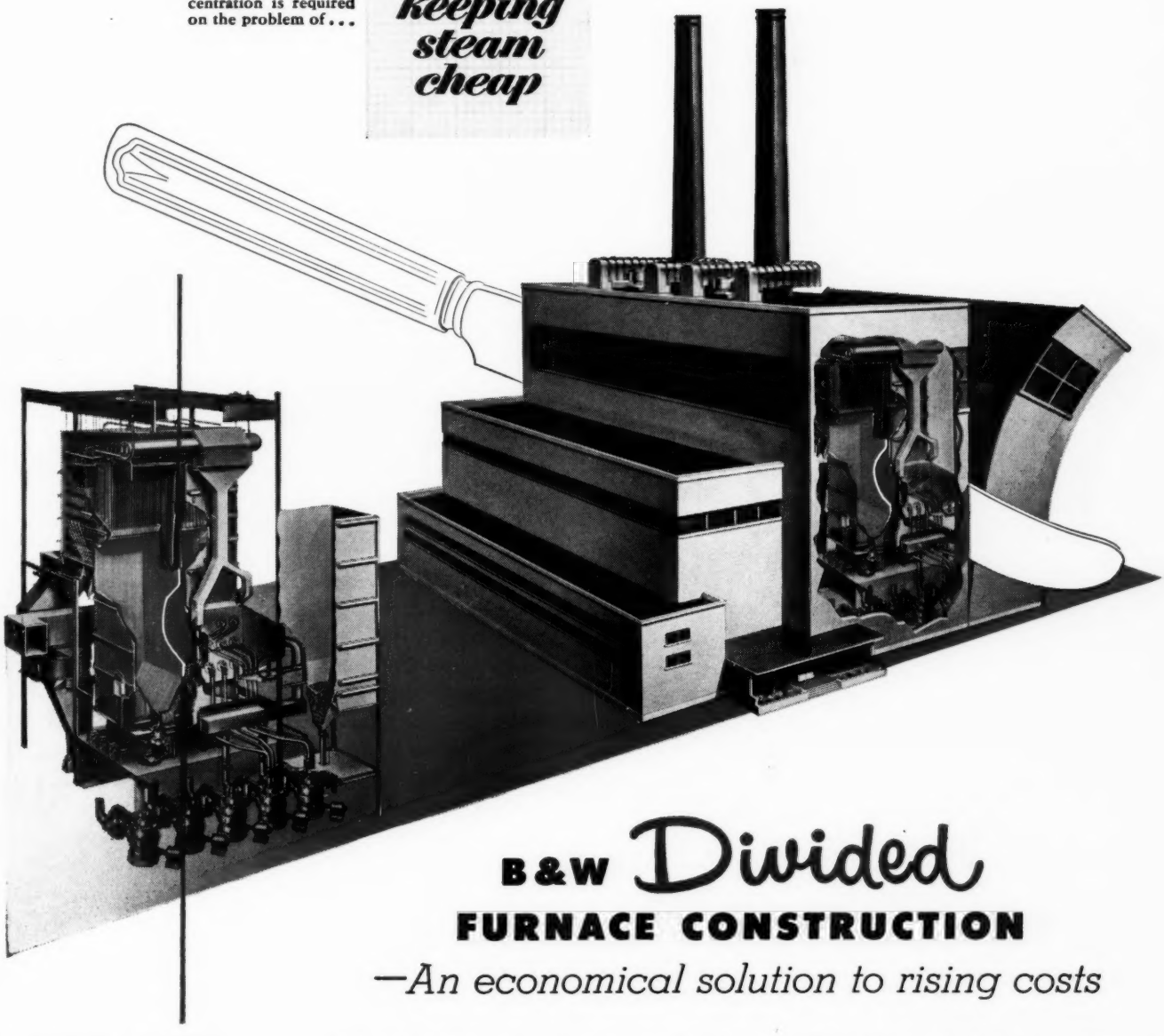
You've undoubtedly read lots of book reviews on books you'd really like for your library, but you didn't order the books because you didn't know where or how to get them. Hughes has told you in his book column that he'll be glad to get any book for you upon request. And that's making the whole thing just about as easy for you as possible.

So let us know how we can help you. If we don't know the answer to your problem, I'll bet we find the answer somewhere—and in jig time, too.

Very truly yours,
Monte J. Sanders, General Manager

Steam is literally the life-blood of our American economy. Through it, the energy in our store of fuels is made available in useable form. Steam always has been taken for granted because it's cheap. But, with rising construction costs making steam plants more expensive, major engineering concentration is required on the problem of . . .

keeping steam cheap



B&W Divided FURNACE CONSTRUCTION

—An economical solution to rising costs

BENEFITS OF DIVIDED FURNACE CONSTRUCTION

- Provides greater cooling area in smaller furnace volume
- Reduces steel and other material costs by keeping boiler and building volume to a minimum
- Lowers furnace construction costs
- Cuts operating costs by reducing slagging in furnace and in convection surface

When fifty to one hundred tons of coal are burned in one boiler in a single hour, the tremendous amount of energy released is difficult to control. To harness this vast outpouring of heat and chill the tons of ash particles to the required temperature, huge furnaces, often 10 to 15 stories high, are needed.

With rising costs of materials and labor, engineers have long sought a way to reduce the size both of boiler furnaces and of the buildings that house them. Division walls were an apparent answer . . . but serious obstacles stood in their way. It was not until B&W's inventions in the field of boiler circulation solved these problems that the divided furnace became a simple, economical answer to rising construction costs. Already, over 75 B&W Boiler units with this important feature are in operation . . . and more than 80 additional units are under construction. All represent savings in size and cost of structure.

Keeping steam cheap . . . for public utilities and for industrial users . . . is a prime engineering objective at B&W, a major aim of our never-ending research and development program. The B&W Divided-Furnace construction is typical of many B&W cost-saving advantages worth investigating.

BABCOCK & WILCOX

BOILER DIVISION

N-150

Prime Mover of Projects—O. H. Pocock

(Continued from front cover)

accomplished largely by him in the hectic days of World War II. When Studebaker's Aircraft Division needed an enormous amount of work done for defense production, and needed it in a hurry, Pocock took personal charge and designed the huge structures in South Bend, Chicago, and Fort Wayne.

This generally difficult assignment called for the design of engine test cells for the increasingly complicated aircraft engines being developed and manufactured. One plant alone required 101 of these test cells, integrated with the manufacturing area. These plants, covering some two million square feet of floor space, started production of engines only 10 months after Pocock began his design work.

Since the pressure days of the war, projects moving across the Pocock desk have totaled in the billions of dollars, and have borne the names of sizable percentage of U. S. and Canadian blue-chip industrial enterprises.

Pocock grew up on a farm near Mansfield, Ohio, and says that, as a youth, he did not entertain a definite ambition to become an engineer. "I did want to get off the farm," he explained.

He attended Ohio State University, where he was elected to Triangle and Sigma Psi, and was graduated as a Civil Engineer in 1916.

His first jobs were with Witherow Steel Company and Cummings Steel Company, designing reinforced concrete. His introduction to consulting engineering firms came in 1920 when he joined Albert Kahn as a structural designer for "hurry-up" industrial projects.

Victor Vallet and Ray Giffels worked over adjoining drafting boards with Pocock in Kahn's office during the building boom of the Twenties. They left to form their own company in Detroit, and one year later asked Pocock to help them out with a particularly ticklish job—the structural design of an addition to Detroit's Hotel Fort Shelby. Pocock has been with G&V ever since, becoming executive vice president in 1951.

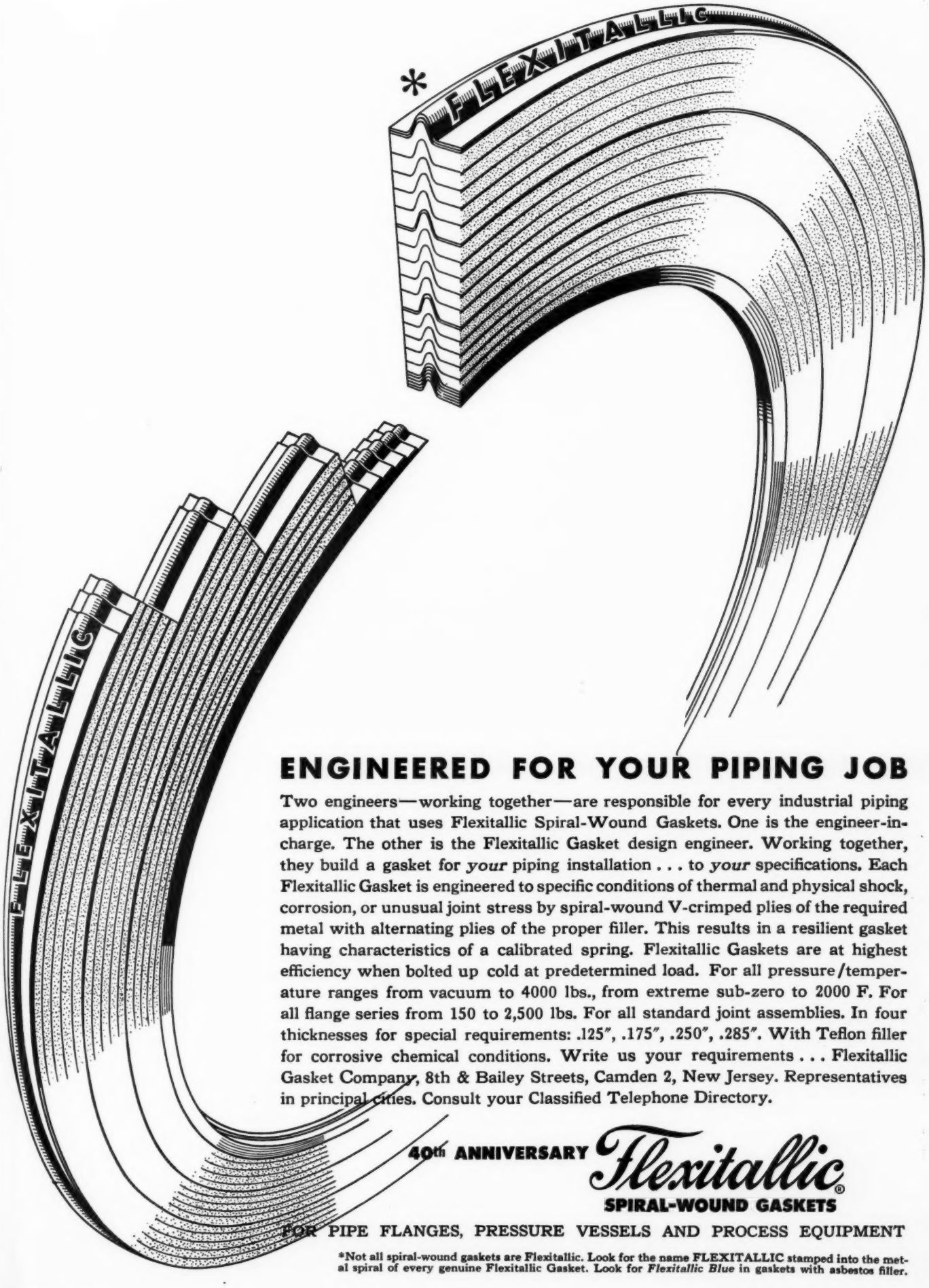
The firm, which today has a staff of 1100 persons, came perilously close to extinction when the depression of the early Thirties struck hard at architect-engineer companies. Two hundred persons worked for G&V in 1929. Soon there were five: Giffels, Vallet, Louis Rossetti, Mrs. Mary Averill, and Pocock. They took on everything and anything to keep the doors open. They worked on plans for non-existent buildngs to keep busy, and this paid off in later years when the firm again prospered.

Busy as he is, Pocock can relax and get away from the office once in a while. Every six years or so, one of the principals succeeds in talking him into a hunting trip. When he can, he plays what he describes as "very indifferent golf". His friends say, however, that it is very much like him to play the game with relentless concentration. They also are a bit wary of high stakes when he plays gin rummy.

Pocock's working hours are long, and it is not unusual to find him in the office from early morning until late at night. He travels almost constantly—consulting, negotiating, planning.

When Pocock finds a spare moment during one of his business trips, you might find him reading papers and articles on nuclear physics or solving structural formulas. Keeping up with and ahead of new engineering problems, jumping from the theoretical question to the practical solution with lightning speed, he is a source of wonder to those who work closely with him. One of his associates remarked, "His habit is silence, until he's got something figured out." He is one of those rare men who really believes "the impossible takes a little longer."

For more than 25 years, Oscar Pocock has been responsible for the general direction of all G&V's complicated engineering work. His quiet affability and seasoned managerial know-how continue to deepen the respect in which he is held by the firm and its clients, as well as his fellow engineers.



ENGINEERED FOR YOUR PIPING JOB

Two engineers—working together—are responsible for every industrial piping application that uses Flexitallic Spiral-Wound Gaskets. One is the engineer-in-charge. The other is the Flexitallic Gasket design engineer. Working together, they build a gasket for *your* piping installation . . . to *your* specifications. Each Flexitallic Gasket is engineered to specific conditions of thermal and physical shock, corrosion, or unusual joint stress by spiral-wound V-crimped plies of the required metal with alternating plies of the proper filler. This results in a resilient gasket having characteristics of a calibrated spring. Flexitallic Gaskets are at highest efficiency when bolted up cold at predetermined load. For all pressure/temperature ranges from vacuum to 4000 lbs., from extreme sub-zero to 2000 F. For all flange series from 150 to 2,500 lbs. For all standard joint assemblies. In four thicknesses for special requirements: .125″, .175″, .250″, .285″. With Teflon filler for corrosive chemical conditions. Write us your requirements . . . Flexitallic Gasket Company, 8th & Bailey Streets, Camden 2, New Jersey. Representatives in principal cities. Consult your Classified Telephone Directory.

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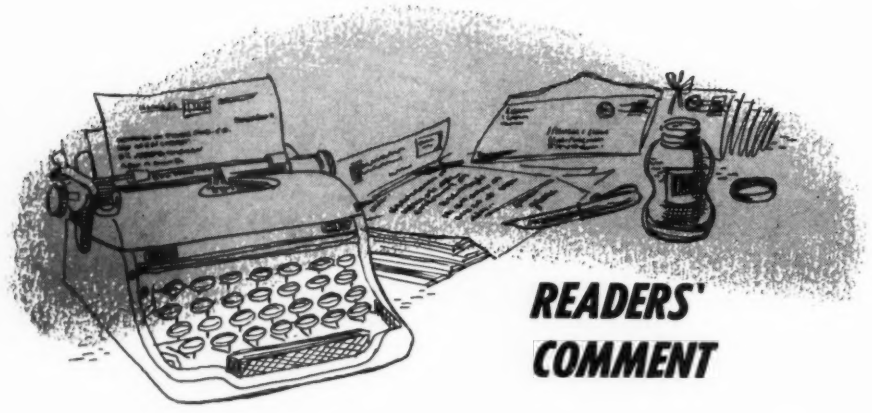


READERS' COMMENT

Short Fly Rod

Sir:

We admit that H. L. Melvin, who's biography you carried on the cover of the March issue, is a remarkable man . . . . but we simply do not believe that he caught a fifteen pound salmon on a six inch fly rod . . . .

Wallace R. Evans
Celanese Corp. of America
Rock Hill, S. C.

Sir:

About this six inch fly rod of Mr. Melvin's, could you send me the name of the manufacturer? It sounds like the answer to many of our packing problems when preparing for a fishing trip.

Thomas P. Hughes
Dept. of Engineering
University of Virginia

● OUR ANGLING EDITOR WAS ON A FISHING TRIP WHEN THE MELVIN STORY WENT TO PRESS. HE HAS RESIGNED TO OPEN A BUSINESS CONVERTING SIX OUNCE FLY RODS TO SIX INCH MODELS.

January, February Issues

Sir:

We find that after perusing the initial copy of CONSULTING ENGINEER, we are more than anxious to be retained on your mailing list. Being selfish, we wish to offer one criticism, we would like to see more articles on steam and heat transfer equipment rather than the electrical, since we are primarily in the steam engineering field.

We have just checked our file and find that we are missing the January and February issues. We would appreciate having you forward these copies so that we may keep our files complete.

Steam Engineering Service Co.
V. F. Vallero
Denver, Colorado

● THERE WERE NO JANUARY AND FEBRUARY ISSUES. REGULAR PUBLICATION BEGAN IN MARCH.—ED.

CE Service

In CONSULTING ENGINEER of December, 1952, is mentioned on page 10 the Minnesota Association of Consulting Engineers.

I should like to come in touch with this Association and beg you to be so kind to give me the address of the said Association.

H. H. W. van Eyk
Consulting Engineer
Rotterdam, Holland

Sir:

We would appreciate receiving one copy of the following article in the March, 1953 issue of CONSULTING ENGINEER:

"Designing Tubular Bus Structures," beginning on page 32.

J. F. Pritchard & Company
Kansas City, Missouri

● LIMITED NUMBERS OF TEAR SHEETS OF ARTICLES ARE USUALLY AVAILABLE UPON REQUEST—ED.

Sir:

Enclosed is $1.00 to cover cost of book "Hydraulic Research in the United States," mentioned in the March issue of CONSULTING ENGINEER.

Thank you for your service.

Colley and Schlee
Detroit, Michigan

● READERS ARE MAKING FULL USE OF OUR BOOK SERVICE. SEE "BOOKS", PAGE 88.—ED.

Old Friends

Sir:

Sometime ago I received the introductory copy of your publication, CONSULTING ENGINEER. Regardless of the staggering number of publications in technical fields, the objectives set forth in the editorial justify this adding of another.

. . . it is inevitable that the publication will be an important factor in establishing public appreciation of the professional status of consulting engineers, whether they be those responsible for services to a number of clients or through the engineering departments of industrial corporations.

Further, it could well be that articles in your publication will re-emphasize to faculties and students the importance of directing a sufficient number of young men toward the consulting field as distinguished from civil service employment.

Perhaps some of my enthusiasm results from finding two friends of the early '30's among your contributors, Walker Cisler and Dave Carmichael.

Wm. J. O'Connell
W. J. O'Connell Associates
San Francisco, California

Subscription Price

Sir:

I thoroughly agree with you that CONSULTING ENGINEER meets a real need as a publication for practicing consulting engineers. In this connection, I wish to congratulate you for the really attractive way you have set up and arranged the various articles and the fine quality of material used therein. I am sure that CONSULTING ENGINEER will take its rightful place among the leading engineering publications of the day.

I shall look forward to receiving my copy of each issue. I would be very glad to pay $5.00 per year subscription fee which I consider to be very reasonable.

Fred L. Pearson
Mechanical and Electrical Engineer
Detroit, Michigan

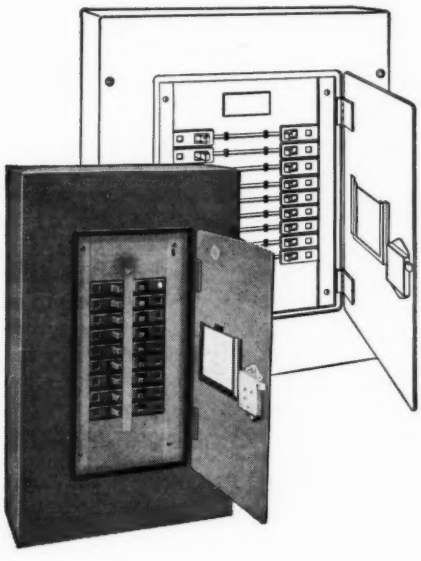
● QUALIFIED ENGINEERS, SUCH AS PEARSON, RECEIVE CE WITHOUT CHARGE. ONLY PERSONS OUTSIDE THE CONSULTING FIELD ARE CHARGED THE *$5.00* SUBSCRIPTION RATE.—ED.

Suggestions

Sir:

While the first issue was very interesting, I want to suggest a few thoughts which may be helpful to you in preparing future issues. Inasmuch as most engineering consultants are registered professional engineers in one or more states, this topic is always of wide interest. While the magazine is primarily to and for engineers, it will spread news information about them to industrialists, bankers, and businessmen. Many of the latter have failed to use consulting engineers to their best advantage. This new publication can serve to acquaint them with the consulting engineer and how they may be employed to improve their opera-

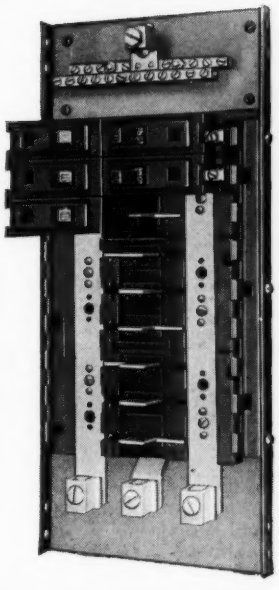
plug-in circuit breaker

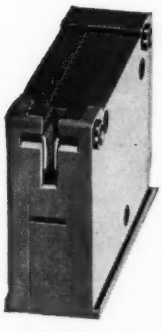


FROM COAST TO COAST

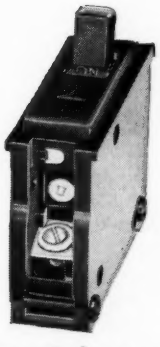
. . . Leading independent panelboard builders are now offering flexible, new I-T-E plug-in panelboard design

Panelboards are now reduced as much as 25% in size, through use of the new I-T-E design. New design provides from 12 up to 42 circuits, sequentially phased for single-phase three-wire 120/240 volts a-c or three-phase four-wire 120/208 volts a-c.





Plug-in pressure-type contacts enable EQP breakers to be clipped directly on bus stabs. Mounting is positive, safe.



Load terminals are securely mounted—easily accessible for quick connection of leads.

Three-position operating handle clearly indicates whether breaker is ON, TRIPPED, or OFF. Service can be restored in a hurry when breaker trips on overload.

Remember—

You don't have to compromise with quality to utilize the new, compact lighting panelboards and load centers now available. Specify I-T-E EQP circuit breakers—and I-T-E panelboard construction—throughout. Your local panelboard builder will gladly give you details.

I-T-E

MOLDED CASE CIRCUIT BREAKERS

I-T-E CIRCUIT BREAKER CO. • 19th and Hamilton Streets • Philadelphia 30, Pa.

tions. Particularly, the small manufacturers who cannot afford to hire an all-time engineer can benefit by retaining a consulting engineer to help solve problems as they occur.

Many consultants are specialists in one particular field of engineering. Describing each month one of these men and what they do would surely be of general interest.

B. R. Wheelock, Jr.
Gilbert Associates, Inc.
Reading, Pennsylvania

Get Down to Earth

Sir:

Some articles in the field of design employ highly accurate mathematical terminations where a lower order of accuracy would be acceptable to many engineers. Many times the user may not have the facilities to check the design or simple instruments with limited accuracy may be the only ones available in which case simplified design data would have to answer the same purpose.

This is not intended to detract from the need of accuracy in some design work, but it is intended to attract attention to the fact that many leading engineers do not have the time, the inclination or their former intimacy with higher mathematics to permit them to use a long, intricate and tedious formula. I am sure the general engineering public who are the most interested in magazine articles would welcome a down to earth discussion remote from the usual haze of calculus and preferably with the fundamentals presented in the form of curves or nomographs.

Robert C. Gordon
Atlas Powder Company
Wilmington, Delaware

Congratulations, But . . .

Sir:

Your treatment of [the article] on wet bottom precipitators is the best I have seen as it appeared in the March issue of CONSULTING ENGINEER. My congratulations on this one as well as for the whole book.

But—and this is a big but—our client, Research Corporation was left out in the cold.

Sincerely, however, your CONSULTING ENGINEER has made a big hit with everyone who has seen it.

Paul F. Palace, Publicity Director
Michel-Cather, Inc.
New York, New York

● RESEARCH CORPORATION CAN COME IN OUT OF THE COLD. WE WANT TO GIVE CREDIT WHERE IT IS DUE. THEY MANUFACTURED THE WET BOTTOM PRECIPITATORS.

Economic News Notes —

E. F. MacDonald
INDUSTRIAL ECONOMIST

RED ENGINEERS. In view of the serious shortage of students emerging from our schools with engineering training, it is interesting to note that about 35% of some 200,000 university students in Communist China are studying engineering. This percentage is likely to increase materially, since the communist program of education reform is aimed at turning out at least 150,000 "senior construction cadres" in the next five years.

STRENGTH AHEAD. Get a personal copy of *The Sustaining Economic Forces Ahead*, a study prepared for the Joint Committee on the Economic Report. In the midst of all the conjecture on what might take the bloom off the boom and on how severe a downturn might be, this report will help you step back and get a reasonable perspective for long-range planning. It suggests that the economy has within itself powerful sustaining forces, stemming from our changed population, in the form of housing requirements, business investment in plant and equipment, and increased needs for schools, hospitals, and highways. It points out that these and other dynamic factors do not guarantee continued or uninterrupted prosperity, but . . . . It's an interesting 70 pages.

RAID ON THE PUBLIC DOMAIN? That's how Justice Douglas regarded the recent decision of the Supreme Court permitting Virginia Electric & Power Co. to go ahead with its four-year delayed hydroelectric plant at Roanoke Rapids, N.C. The Court acknowledged that the decision upholding the authority of FPC to grant the private utility the license issued in 1951 "may affect a substantial number of important potential sites for the development of hydroelectric power." but they backed-up the FPC. The ruling was eagerly awaited by other utilities that have had hopes and plans for power construction on rivers "set aside" by Congress.

INDUSTRIAL FUEL LEGISLATION. There are a number of bills—21 to be exact—pending in Washington, sponsored by the coal industry and designed to restrict residual fuel oil imports to 5% of domestic demand. Opponents of such legislation predict dire consequences in the form of sharp rises in prices of residual fuel oil, bituminous coal, and manufactured and natural gas if the legislation is enacted.

BRIGHT PROSPECTS. About $3 billion will be spent this year on new road construction and maintenance, up 18% from last year. With an estimated 30% of such outlays going to manufacturers of road-building equipment, road machinery companies should have some good reports for stockholders. Stiffening competition, however, will continue to restrict profit margins. In view of Federal government agreements with states, it isn't likely that Federal funds for highways will fall under the budget-balancing axe.

NEXT WEEK'S NEWSPAPER. A businessman, asked what he would like to have above all other things in the world, replied, "Next Friday's newspaper." *Survey of Consumer Finances*, recently released by the Board of Governors of the Federal Reserve System, will not fill the bill that well, but it does disclose attitudes and possible actions of the most important factor in any business—the consumer. Consumers report confident attitudes toward their financial conditions, and more of them plan to buy new autos this year than planned to early in 1952 or 1951. Plans to buy major household goods, especially television sets and furniture, are substantially more numerous than a year ago, and plans to purchase new and used houses are slightly greater. On the other hand, intentions to buy refrigerators appear little changed. The proportion of consumers who feel times are good for making major purchases has increased considerably since early 1952.

ALL UNDER ONE ROOF. Construction will soon begin in Baltimore on one of the largest neighborhood shopping centers in the country. The project, providing 450,000 sq. ft. of store space and costing $8 million, will have at least 40 stores, including a couple of large department stores, and a ten-story office building. Unique features include: covered walkways between stores, a common roof over all stores, underground truck tunnel servicing all stores, drive-in parcel pickup stations, and parking space for over 4,000 cars.

AND GROWING FAST. Along with atomic energy and defense production, industrial research is one of the newer major business activities. Over a fourfold increase has occurred in dollar outlays in this field since the pre-war period. In 1951 American industry spent an estimated $2.4 billion on research and development, an additional $875 million was spent by the Government in its own lab, and the research bill of colleges and universities added $300 million more. Almost half the total of over $3.5 billion was concentrated in electronics and aeronautics.

TAX-EXEMPT CONSTRUCTION. Opposition to issuance of municipal bonds in order to finance construction of industrial plants which are leased to private concerns has opened up two new and possibly decisive fronts. A bill, H.R. 2734, has been introduced in the House which would remove tax exemption on such issues unless backed by the general credit of the issuer. A second attack is directed against a particular issue, the $1.3 million flotation by Florence, Ala., used to build a plant for Stylon Corp. Here the Commissioner of Internal Revenue has been asked to remove exemption from Federal taxes from this and similar issues and an appeal is before the SEC to put such issues under its regulations.

Scraps & Shavings

PUBLIC RELATIONS OFFICE, Structural Clay Products Institute, reports, "More than 80 per cent of a brickmason's time is spent stooping, squatting, and squinting at his work." Even at that he is probably more productively occupied than the jerk who found time to make the survey.

THE OTHER DAY we had occasion to refer to that weighty volume, "National Associations of the United States," published by the Department of Commerce. It lists about 4000 trade, professional, and civic associations, national in scope. It gave us a feeling that in this country, we may just possibly be a little over-organized. Personally, we have a hard time resisting any smiling face announcing to us that we have just been pledged to its favorite lodge or association. We carry some rare membership cards in our own wallet, but it seems there are some we have missed. We are particularly fascinated by the American Button Mould Manufacturers Association; American Cryptogram Association; American Hot Dip Galvanizers Association; National Horseshoe Pitchers Association (1000 members); and when it comes to specialization, we like the Manufacturers of Hard Edge, Flexible Back, Metal Cutting Band Saws. W. P. Jeffery is secretary (or was when our edition was published) and they are in the same office with The Hack Saw Manufacturers of America, a much broader group with wide interest.

MUSIC IN THE PLANT does not seem so popular as it was a few years back, but in case any of your clients are contemplating installations of this sort, they may be interested in knowing that Lewis H. Moomaw, a California rancher, has found that piping music to his hen house has caused the chickens to lay more eggs. There is some suggestion of a moral in this story.

A RUM PILOT PLANT, with a daily capacity of 150 proof gallons of rum, is now being operated by the University of Puerto Rico. We can remember when a little experimental work along this line was being conducted in the basements of most fraternity houses at American universities, but nothing on anywhere near so grand a scale.

BOBBY PINS AND HAIR PINS take 10,000 tons of steel annually, according to a report of the American Iron and Steel Institute. We can well believe these figures. The other night we looked under the cushion of the big chair in the living room, and we found a full month's output.

RAIN STIMULATION IN CUBA IS VERY IMPORTANT AT CERTAIN TIMES OF THE GROWING SEASON. HERE IS A SMOKE GENERATOR BEING LIGHTED BESIDE A CANE HOIST. ALL TRANSPORTATION IS ACCOMPLISHED OVER THE SUGAR PLANTATION RAILROAD SPUR.

Competing With N

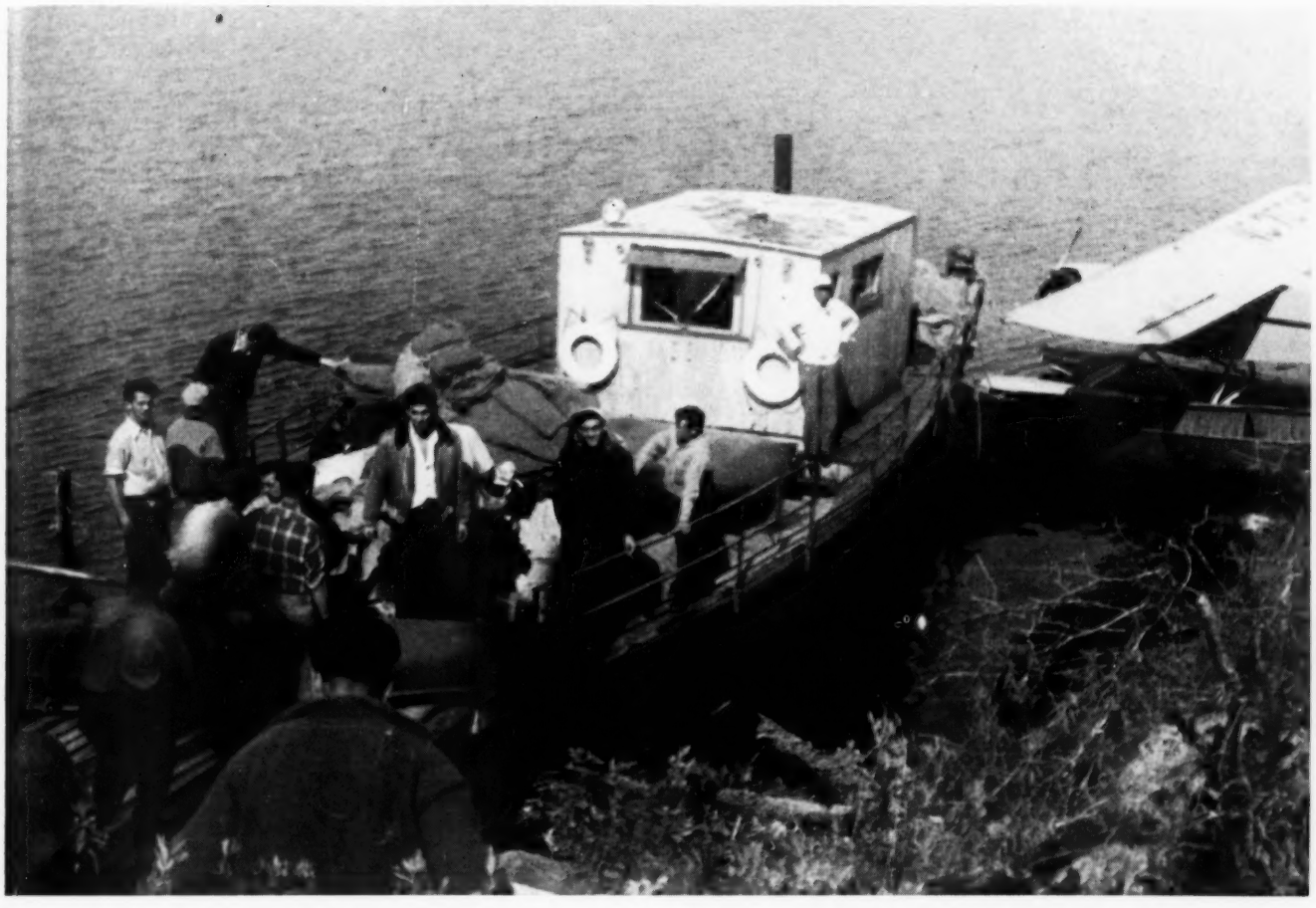
DR. WALLACE E. HOWELL

Dr. Howell heads his own meteorological consulting firm of Wallace E. Howell Associates, Inc. As a firm they have conducted numerous rainfall stimulation projects in South America, the Caribbean, the United States, and Canada.

After receiving his AB degree in physics from Harvard, Dr. Howell entered MIT and obtained his MS and ScD in Meteorology. While pursuing advance study at MIT, he became assistant Weather Bureau Regional Forecaster for New England. During World War II he was a Weather Officer ana served both in the United States and Europe.

From 1948 to 1952 his efforts were in cloud physics research at Harvard's Blue Hill Meteorological Observatory. During this time he was also Director of the Mount Washington Observatory, Gorham, N. H. Dr. Howell formed his own company in 1951.

Competing with nature to supply rain for production of sugar, cotton, and for hydroelectric power has proven to be a profitable venture. First step in the process of cloud stimulation is the compilation of the necessary data to make the project a success. Many days of investigation by competent meteorologists must preceed the final seeding of the clouds.



IN LAKE ST. JOHN REGION OF QUEBEC, THE CAMP SITE HAD TO BE ESTABLISHED BEFORE THE CLOUD-SEEDING SMOKE GENERATORS COULD BE OPERATED. THESE SITES WERE SCOUTED BY AIR, WATER, AND LAND AND COMPLETELY STOCKED WITH FOOD AND EQUIPMENT.

Nature to Provide Rain

Water is one of the most ancient concerns of mankind and one of the most closely bound up with its welfare. It is no exaggeration to say that the engineering profession has its most primitive origins in the task of designing and executing irrigation works to provide water for agriculture. Throughout the whole of recorded history, and emphatically so at the present day, the harnessing of water is one of the great and continuing tasks that has challenged each generation of engineers, whether it be for irrigation, transport, flood control, domestic water supply, or power development.

Through this long period of history, mankind has had to depend on the often capricious bounties of nature to supply the water for these engineering works. Indeed, so fundamentally important has rainfall always been that in many primitive civilizations the magic procedures associated with the provocation of rain, like the rites that maintained the seasons in their course, were the zealously guarded prerogatives of the most powerful chiefs. Through the ages, however, and until the past few years, the only sure formula for the rainmakers, ancient and modern, was the infallible rule that it always rains at the end of every drought.

It is small wonder, therefore, that the discovery in 1946, of a sound scientific basis for rain stimulation captured the imagination of people everywhere and gave rise to not a little controversy. In the space of a few years, experiments have emerged from the laboratory, given sometimes spectacular performance in the atmosphere, and have been put to workaday tasks to supplement the shortcomings of natural rain. In short, the witch-doctor has given way to the meteorologist, and stimulation of water at its source in the atmosphere has joined the ancient engineering

IN THE CANADIAN WILDERNESS, RADIO COMMUNICATIONS ARE EMPLOYED FOR TRANSMITTING OPERATIONAL ORDERS TO THE REMOTE CAMP SITES AND FOR OBTAINING WEATHER DATA REPORTS IN RETURN. COMPLETE DATA MAKES POSSIBLE DECISIONS FOR CLOUD-SEEDING.

sciences. Basis of rainfall stimulation lies in the discovery of a method of disrupting the colloidal stability of clouds in a certain state. Clouds that are not precipitating are made up of particles too small to fall to the ground. Typical fair-weather clouds contain several hundred droplets per cubic centimeter, but the droplets are so tiny it would take several hundred million of them to fill an ordinary teaspoon. Before precipitation can fall, some mechanism must operate to replace the many small particles with vastly fewer particles of vastly larger size. In nature, this change is brought about in one of two ways.

Rainmaking Science

If a typical cloud is cooled to a temperature below freezing, the water droplets generally remain unfrozen but supercooled. The atmosphere contains, in various concentrations, particles capable of acting as ice-forming nuclei at temperatures mostly below 5 F. When the supercooled cloud reaches these temperatures, the particles initiate the growth of ice crystals, which then grow rapidly at the expense of surrounding droplets until they become large enough to fall, thus becoming snowflakes. At Mount Washington, New Hampshire, counts carried on for several years show the number of these natural nuclei to vary from fewer than one to more than a million, but usually a few hundred to a few thousand, per cubic meter.

Artificial Inoculation

Rain stimulation in supercooled clouds is accomplished by inoculating them artificially with ice-forming nuclei. Not only can nuclei be produced in sufficient numbers to overcome deficiencies that may occur in nature, but the nuclei produced are more active than the natural ones, initiating freezing at the freezing point itself or at about 23 F, according to the agent used. In the earliest seeding experiments, pellets of dry ice (solid carbon dioxide) were dropped into the clouds. Each pellet left behind it a trail containing myriads of minute crystals of ordinary ice produced by the momentary chilling of the air in contact with the hundred-below cold of the pellet.

Silver Iodide Smoke

Use of dry ice, however, has now been largely supplanted by silver iodide smoke, the particles of which act as synthetic ice crystals, similar in crystalline structure to ice. Because of the higher temperature at which the growth of precipitation particles can begin, snowflakes form in clouds earlier than they would form naturally, and in clouds that would have dissipated, partially or completely, before the natural processes leading to precipitation could have been carried through. In this way the conversion of the cloud to precipitation is made more efficient and, in borderline cases, more likely to take place.

Stimulation in the Tropics

In tropical areas, where clouds may become extraordinarily rich in condensed water before their tops reach the freezing level, rain is sometimes set off by a second agglomerating mechanism. Especially in maritime locations, the air has been found to contain, in addition to the ubiquitous condensation nuclei of very small size, a few relatively large particles of salt that are capable, within these clouds, of forming droplets by deliquescence that sometimes grow to be as much as 50 microns in diameter. Once they have reached this size, they begin to have a falling speed large enough to bring them into collision with other cloud drops, causing them to grow by accretion and become raindrops. The raindrops thus formed initially may become so large that they break up into smaller drops, each of which grow and breaks up to perpetuate a chain reaction sweeping the cloud's water down in the form of a rainshower. This growth by accretion occurs also in clouds outside the tropics once the first few precipitation particles have formed, but it is only in the tropics that conditions are right

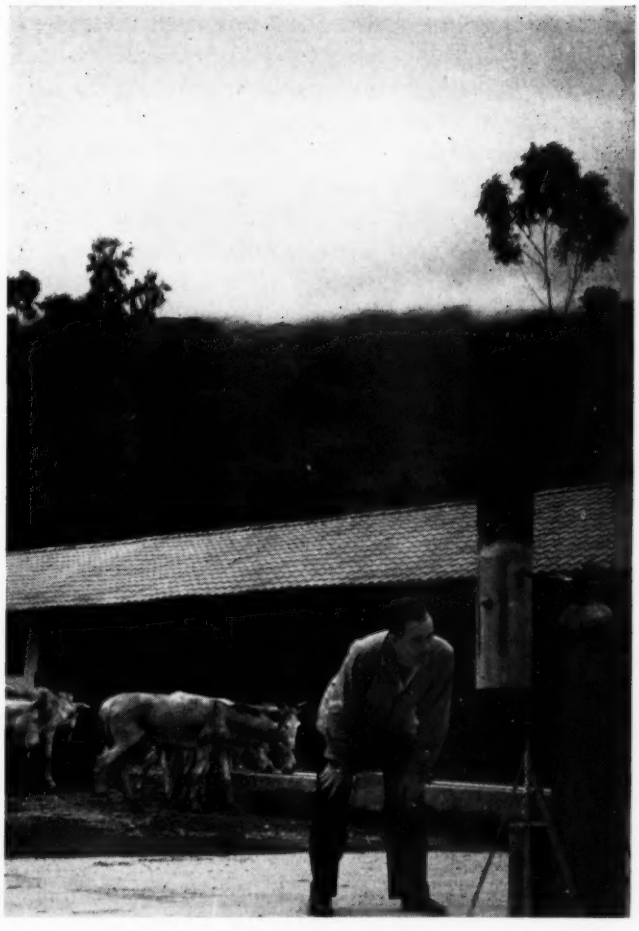
for these essential first few particles to form without the intervention of ice-forming nuclei.

Inoculation of dense water-clouds with large water droplets has shown that, in these clouds too, the natural rainmaking processes can be effectively triggered by artificial means—by seeding with water droplets or salt particles of the right size. By these seeding methods, rain can be stimulated whenever the natural weather conditions provide favorable clouds—that is, whenever conditions approach or reach those that give natural rain. If the clouds are not there, or if they are too thin and shallow, nothing can be done to produce rain. At this point, the scientists must still yield to the magicians.

Rainmaking Clients

In the first flush of enthusiasm about reports of successful rain stimulation, it was conjectured that this new art would have its main usefulness in watering arid or semi-arid regions such as the American desert, the grazing lands around the borders of the Sahara, and the often drought-ridden lands of the middle east. As a matter of fact, however, the applications have followed a different but perfectly sensible pattern. *Rainmaking* has been most successful and most widely applied not where water has the highest value per unit of measure, but where the total production of value based on water is largest.

For example, extensive rain stimulation activities have been carried on in a region of eastern Canada where water is so plentiful that the area is distinguished by its liberal supply of lakes and swamps—the reason being that these lakes feed the largest privately owned hydroelectric development in the world, and additional water there has quickly convertible cash value in the form of refined aluminum. The same general reasoning holds in the tropics, where rainfall stimulation has been applied on an expanding scale, even in climates having natural rainfall of nearly 60 in. annually, because of the presence of large-scale intensive agriculture—sugar cane—that is intimately dependent upon water for productivity during certain stages of the growing season.



THIS CLOUD-SEEDING POST IS HIGH ON THE MOUNTAINSIDE IN THE PERUVIAN ANDES. RAINFALL IN THIS VALLEY SUPPLIES IRRIGATION WATER FOR THE VAST SUGAR PLANTATIONS ALONG THE DRY BUT FERTILE PERUVIAN PACIFIC COSTAL LAND STRIP.

HYDROLOGIC PROBLEMS OF GLACIER MELT AND EVAPORATION ARE STUDIED IN CONNECTION WITH THE RAIN STIMULATION.

Aid to Agriculture

Many more examples could be quoted, all having in common the loss of needed productivity when natural supplies of water are below the requirements for maximum productivity. Potential benefits for arid lands still exist, but such lands require the integrated development of increased productivity, involving complex social and commercial changes, that must go along with rain stimulation before the potential value of the latter can be realized, a situation that will tend to complicate its application.

For the most part, the leaders in backing the practical application of rain stimulation for industry, agriculture, and other uses have been corporate entities that control or have interests concentrated in an area from fifty to a hundred square miles on up to several tens of thousands of square miles. Some are cities controlling large watersheds for domestic water supply, others are hydro electric companies, and yet

others are agricultural concerns or such integrated water users as the pulp and paper companies, which depend on water for tree growth, for driving the logs to the mill, for the process water at the mill, and as a source of power. In addition, there has been some success in organizing *weather improvement associations* among farmers and even among incorporated townships and counties in the farming states, for the sake of contracting for rain stimulation services, but difficulties have been quite apparent in keeping these associations from dissolving because of disagreements among the individual members.

Particularly in the case of the larger corporations, attention was directed toward the possibilities of rain stimulation through keen awareness of the hydrologic situation, and many of them have long kept weather records and even maintained staffs of hydrologists to aid them in making the best use of their water resources. In general those companies best informed about their water resources and those that can most easily attach a value figure to these resources have led the way in undertaking practical rain stimulation.

Rainmaking in the Field

It is at this point that the professional *rainmaker* enters the picture, for the development of a plan of operation requires integration of the hydrologic information not only with the broader point of view of synoptic climatology and physical meteorology—the study of the patterns of daily weather that combine to create the climate and the processes by which they function (for it is the daily weather that must be dealt with in the field), but also with experience in the cloud seeding operations that must be carried out in the field and the requirements for access, communications, and supply that are necessary for the success of the project.

Review of Data

The planning stage of a new project begins with a careful review of all available climatic information and interpretation of it in terms of synoptic climatology. From experience gained with seeding in various weather situations, an estimate can then be made of the prospective results of the program. When unfamiliar territory is under consideration, the study is normally combined with a field survey that includes study of local meteorological peculiarities of the area under consideration and the practical aspects of operation within it, such as road and telephone networks and suitable operating points.

Operating Procedure

Upon completion of the study, with all the pertinent facts available, a conference between the sponsors of the project and the meteorological engineers conducting it establishes the pattern that operations are to follow. In most cases, all phases of the actual operation are carried out by the meteorological firm. In some cases, especially abroad, where the sponsoring company has extensive facilities in the field, it works out to best advantage for it to provide unskilled labor and sometimes transportation and communications available within its customary practices. The meteorological consultants still provide the technical equipment and supplies, professional meteorological services, and close supervision of the field operations.

Rainmaking Limitations

At this stage in the proceedings it is essential that all parties be aware of the limitations of rainmaking and the limitations imposed by terrain conditions and operating facilities.

Usually, the establishment of the project is simple and straightforward. A field meteorologist takes charge, and operating sites are prepared. These may be anything from corner gasoline station where a mechanic can act part-time as generator operator, to an observatory established for the purpose on a mountain top, or a camp established by air on a remote lake and manned by two operators so that if one man is incapacitated by an accident the other man can summon help. Or the generators may be operated on a portable basis, being stationed, with their operators, by trucks on a day-to-day basis.

Distribution of Supplies

Equipment and supplies are distributed; communications schedules are set up that bring up-to-the-minute weather information to the field meteorologist and enable him to pass on his instructions to the generator operators. The first mission plan goes out, the smoke generators are lit, and the project is under way. The daily routine starts with an estimate of the meteorological situation, based on continuing analysis of weather data as it arrives at the home office or the regional meteorological office.

On the basis of this estimate, information for mission planning is sent to the project meteorologists, who completes his mission plan for the day and sets it into operation. Later in the day, a second estimate is made, on the basis of which a preliminary mission plan for the following day is prepared and operating personnel alerted accordingly. Meanwhile, the project meteorologist is in a position to make last-minute emendations on the mission plan to take advantage of local situations that he observes developing or to correct for occasional inaccurate forecasts.

Another essential part of the project meteorologist's job is the assembly of the rainfall records from the target area and surrounding regions for use in computing the degree of stimulation achieved, and in studying the effectiveness of the day-by-day operations as a check on the quality of the meteorological estimates and the mission plans. Without such records he would not know the results of his work.

The most challenging phase in the work of the

consultant meteorologist in connection with rainfall stimulation is evaluation of the results after an operating phase of the program, or a specified period of operation, has been concluded. Evaluation can mean all things to all men. To the statistician it may mean comparison with past data, computation of correlations between rainfall on the target and on nearby control regions, and derivation of figures expressing the degree of confidence that can be placed in the outcome. To the meteorologist it means a critical look at the quality of his estimates of the meteorological situations, the adequacy of the mission plans, and the effectiveness of different variants of the techniques employed during the operation.

Profit Ultimate Goal

The motivating force behind all these projects (except for a few research projects, mostly government financed) is still the desire for profit, and the businessman sponsor looks at evaluation in terms of opportunity for profit. By and large, if operations are successful in producing even as little as five or ten per cent stimulation of rainfall, the relatively small operating costs are repaid many times over in the value of the resulting water. A relatively large degree of uncertainty as to the amount of stimulation may be tolerable to him if the profit margin for the operation is wide. In fact, in many operations the breakeven point for profitable operation is reached at a percentage of stimulation so low that it would be extremely difficult, or even impossible, to attach any statistical significance if no better result was obtained.

Amount of Stimulation

In practice, the statistical confidence figure that can be attached to the results of different projects vary widely depending upon the amount of past data available for comparison, the density of the rain gage network in and around the target, and the natural variability of the rainfall in the particular area. The amounts of stimulation indicated range from around 10 or 15 per cent increase of rainfall above that which would have been expected by comparison of the target with its surroundings, up to more than 50 per cent, and in a few cases even more. The levels of statistical significance vary from no indicated significance to less than one chance in a thousand that the increase is due to chance happenstance.

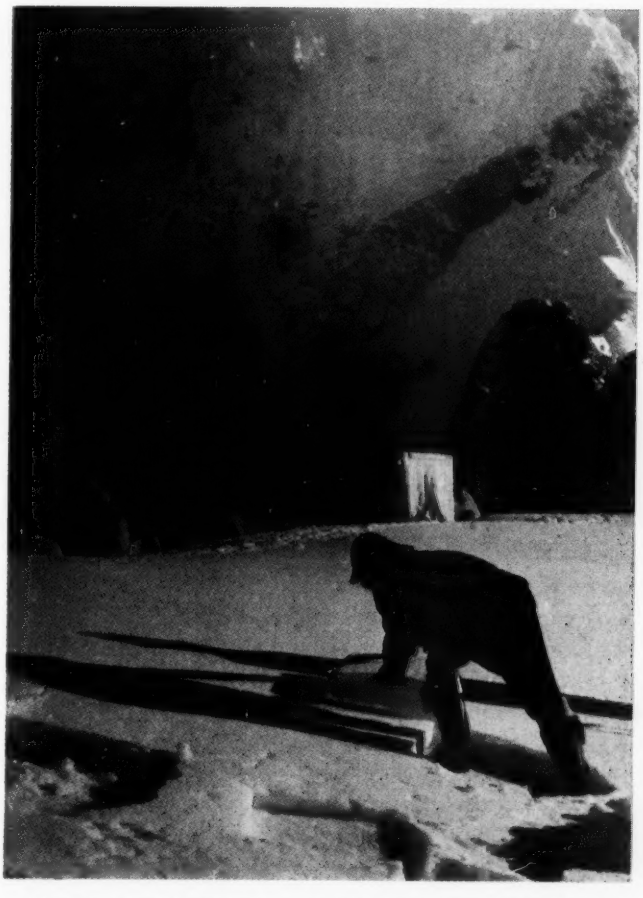
Cause of Fluctuation

In the sum, when the results of many projects are considered, it is apparent that much of the variation in indicated results arises from the unavoidable natural fluctuations round the mean rainfall relationship between the target and the selected control areas. Even if it were possible to produce an exact 25 per cent stimulation on every occasion, therefore, the available means of evaluation would indicate an apparent fluctuation around this figure. Naturally, it is most important that the sponsors and those responsible for sponsorship decisions be aware of these circumstances in making the business evaluation of a rainfall stimulation program.

Rainmaking for the Future

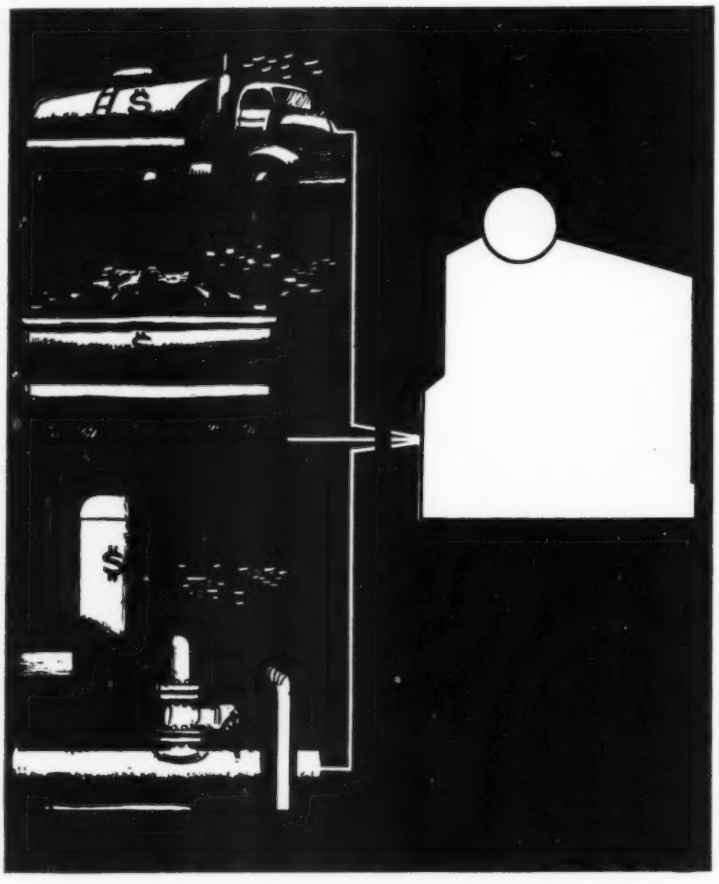
Though the new science of rain stimulation has turned out to be a thriving infant, and the shape of its adult frame is already apparent, it is still risky to attempt a forecast of its full adult capabilities and powers. There is no doubt that there are many opportunities waiting to be grasped for application of the science by industry and agriculture on an expanding scale. As this expansion continues, the day is predictable when integration of projects into groups, according to natural geographical and industrial areas, will become a practical necessity.

It can even be foreseen that interstate and international agreements will be necessary for the regulation of weather modification activities. But before that stage is reached, we may look for a far better general understanding by the business and engineering community of the capabilities of cloud seeding and the gradual development of a body of law and practice that will increase its applicability.



CAMP ON THE AMAZON SIDE OF THE ANDES IS AT 16,500 FT. STUDIES ARE FOR A PROPOSED HYDROELECTRIC STATION.

What are Parity Prices of Fuels



W. S. MAJOR, Project Engineer
Machinery Division, Dravo Corporation

William S. Major graduated from Lehigh University in 1924, with a degree in Chemical Engineering. After a brief period of research on briquetting of coal, he spent 21 years with the American Engineering Co. His duties covered industrial stoker engineering, erection, operation, and boiler testing; followed by sales engineering in Cincinnati and Chicago and then supervision of the company's district offices and agencies.

In April 1946, he joined Bituminous Coal Research, Inc., as development engineer in research and promotional activities on the improved utilization of bituminous coal. With R. B. Engdahl of Battelle Memorial Institute, he developed the manual "Application of Overfire Jets to Prevent Smoke from Stationary Plants".

In June 1950, he affiliated with Dravo Corp. as project engineer in the Machinery Division. Mr. Major is an executive member of the Fuels Division of ASME, past Chairman of Pittsburgh Section of ASME, a registered professional engineer in fuel technology, and the author of a number of papers on industrial stokers and various aspects of combustion engineering.

Parity-of-fuels can be defined as the prevailing condition when the market prices of the fuels are such that they act exactly even with each other as far as the consumer is concerned. In the establishment of parity prices, it is necessary to carefully evaluate such factors as combustion efficiency, operating costs, fuel handling costs, maintenance, reliability, and other pertinent considerations. The break-even point will vary in different plants and may actually vary within departments of the same plant. For example, it is conceivably possible to profitably fire oil instead of coal in a copper melting furnace at a much higher oil price than could be tolerated in firing steam boilers in the same plant. The ash in the coal might affect the molten copper and cause more waste than oil firing whereas this situation would not prevail in the boiler house.

In larger industrial plants and central stations where modern coal handling systems are employed, the over-all thermal efficiency actually may be higher with coal than with oil. This is because residual fuel oils contain more hydrogen than coal. Therefore, the wet stock loss, or the loss due to the latent heat of vaporization of the water produced by the combustion of the hydrogen in the fuel oil, will be greater than it will be with coal. Furthermore, there are other circumstances where oil firing is penalized when compared to coal firing. For instance, on some public utility boilers designed for pulverized coal firing, it is impossible to obtain as high a total superheat steam temperature with oil as with coal. This results in reduced thermal efficiency of the steam turbines and sometimes restricts the use of fuel oil.

Commercial Applications

Because there are many factors to take into account when comparing fuels, it is impossible to set up parity fuel price tables that are suitable for all condi-

TABLE 1 — RELATIONSHIP OF FUEL PRICES TO PROVIDE THE SAME QUANTITY OF HEAT AT THE SAME COST FOR HEATING SYSTEMS IN HOTELS, APARTMENTS, COMMERCIAL BUILDINGS, AND SIMILAR INSTALLATIONS

Fuel oil						Gas							Coal									
No. 2 oil		No. 5 oil		No. 6 oil		Manufactured		Mixed		Natural			Hand firing					Stoker firing				
Estimated efficiency, per cent*																						
75	70	75	70	75	70	75	75	75	75	75	75	75	60	60	60	60	60	65	65	65	65	65
Heat Content																						
Btu per gal in thousands						Btu per cu ft							Btu per lb as fired					Btu per lb as fired				
140	140	147	147	152	152	525	540	550	600	800	1000	1100	11,000	12,000	13,000	13,500	14,000	11,000	12,000	13,000	13,500	14,000
Fuel prices																						
Cents per gal						Cents per thousand cu ft							Dollars per 2000 lb ton**					Dollars per 2000 lb ton**				
3.3	3.1	3.5	3.2	3.6	3.4	12.4	12.8	13.0	14.2	18.9	23.6	26.0	3.42	3.80	4.17	4.36	4.55	3.77	4.17	4.59	4.79	5.00
3.7	3.4	3.9	3.6	4.0	3.7	13.8	14.2	14.5	15.8	21.0	26.3	28.9	3.88	4.30	4.72	4.93	5.14	4.27	4.72	5.18	5.41	5.64
4.1	3.8	4.3	4.0	4.4	4.1	15.2	15.7	15.9	17.3	23.2	28.9	31.8	4.34	4.80	5.27	5.50	5.73	4.77	5.27	5.77	6.03	6.28
4.3	4.0	4.5	4.2	4.7	4.4	16.2	16.7	17.0	18.5	24.8	30.9	34.0	4.69	5.18	5.68	5.92	6.18	5.14	5.68	6.22	6.49	6.75
4.5	4.2	4.7	4.4	4.9	4.6	16.9	17.4	17.7	19.3	25.8	32.2	35.5	4.92	5.43	5.95	6.21	6.47	5.39	5.95	6.51	6.80	7.07
4.7	4.4	4.9	4.6	5.1	4.8	17.7	18.2	18.5	20.1	26.8	33.6	36.9	5.16	5.69	6.23	6.49	6.77	5.65	6.23	6.81	7.10	7.39
4.9	4.6	5.1	4.8	5.3	5.0	18.3	18.8	19.1	20.8	27.9	34.8	38.4	5.38	5.94	6.50	6.78	7.08	5.90	6.50	7.10	7.41	7.71
5.1	4.8	5.3	4.9	5.5	5.2	19.0	19.5	19.9	21.7	28.9	36.1	39.8	5.62	6.19	6.77	7.06	7.36	6.15	6.77	7.40	7.72	8.03
5.3	5.0	5.6	5.2	5.8	5.4	20.0	20.6	20.9	22.9	30.5	38.1	41.9	5.97	6.58	7.19	7.49	7.80	6.53	7.19	7.84	8.18	8.51
5.5	5.2	5.8	5.4	6.0	5.6	20.7	21.2	21.7	23.6	31.5	39.4	43.3	6.20	6.83	7.46	7.78	8.09	6.78	7.46	8.14	8.49	8.83
5.7	5.4	6.0	5.6	6.2	5.8	21.2	22.0	22.4	24.4	32.6	40.8	44.8	6.43	7.08	7.73	8.06	8.38	7.03	7.73	8.44	8.80	9.15
5.9	5.5	6.2	5.8	6.4	6.0	22.0	22.7	23.2	25.2	33.6	42.1	46.2	6.66	7.33	8.01	8.35	8.68	7.28	8.01	8.74	9.11	9.47
6.4	6.0	6.8	6.3	7.0	6.5	24.1	24.9	25.3	27.6	36.8	46.1	50.7	7.36	8.09	8.83	9.20	9.56	8.03	8.83	9.63	10.03	10.42
6.8	6.4	7.2	6.7	7.4	6.9	25.5	26.2	26.7	29.1	38.9	48.6	53.5	7.82	8.60	9.38	9.77	10.16	8.53	9.38	10.22	10.64	11.06
7.2	6.7	7.5	7.0	7.8	7.3	26.9	27.7	28.2	30.8	41.0	51.2	56.4	8.28	9.11	9.93	10.34	10.74	9.03	9.93	10.81	11.25	11.70
7.6	7.1	7.9	7.4	8.2	7.7	28.3	29.1	29.7	32.3	43.2	53.9	59.3	8.74	9.61	10.47	10.90	11.33	9.53	10.47	11.41	11.87	12.34
8.1	7.5	8.5	7.9	8.8	8.2	30.4	31.2	31.8	34.8	46.3	57.9	63.7	9.44	10.37	11.29	11.76	12.21	10.29	11.29	12.29	12.79	13.30
8.7	8.1	9.1	8.5	9.4	8.8	32.2	33.3	34.0	37.1	49.5	61.8	68.1	10.13	11.12	12.11	12.61	13.10	11.04	12.11	13.18	13.72	14.26
9.4	8.8	9.9	9.2	10.2	9.5	34.7	36.2	36.9	40.2	53.6	67.1	73.7	11.06	12.13	13.20	13.74	14.28	12.04	13.20	14.37	14.95	15.53
10.1	9.4	10.6	9.9	11.0	10.3	38.0	39.1	39.8	43.4	57.9	72.4	79.6	11.99	13.14	14.30	14.88	15.46	13.05	14.30	15.56	16.18	16.81
11.1	10.3	11.6	10.8	12.0	11.2	41.4	42.6	43.4	47.4	63.2	78.9	86.8	13.14	14.41	15.67	16.30	16.93	14.30	15.67	17.04	17.72	18.41

*Fuel oil efficiencies of 75 and 70 per cent are included to cover operation with units designed for oil firing and with converted units.

**In establishing parity prices, 75¢ per ton was added to the delivered coal prices shown to cover extra handling costs when coal is used.

tions. If such tables, however, are developed to meet installations within a certain class, the resultant parity prices are quite helpful in judging the economic feasibility of a certain priced fuel. For example, Table 1 has been developed to show the relationship of fuel prices to provide the same quantity of heat at the same cost for the three basic fuels; coal, oil, and gas when used for heating installations common to most hotels, apartments, and commercial buildings. The efficiencies assumed for this table reflect the low load factor, longer banking periods, and limited automatic controls that are typical of these systems.

Coal Handling Adjustment

In establishing parity prices, 75¢ per ton was added to the delivered coal prices shown in the table to cover additional handling costs of coal and ashes. While this extra charge will vary, it is a reasonable cost estimate for such service conditions. At smaller plants where coal is stored at firing floor level, costs of moving coal to the stoker hopper can be reduced by applying mechanical systems. One arrangement is a bulk flow conveyor designed to transport the coal from the point of storage to a horizontal screw conveyor which discharges to the stoker hoppers.

Industrial Applications

Parity fuel prices for industrial applications are, of course, quite different. In many industrial plants, modern firing equipment, appropriate fuel handling systems, and better operating procedures combine to provide higher efficiency and lower fuel handling costs. Thus, when developing the tables, the extra handling charges for coal firing were reduced to 50¢

per ton, and the efficiencies were increased to approximate average performance at industrial plants with modern steam generating equipment.

Table 2 provides a convenient guide for estimating parity fuel prices for industrial plants operating boilers without heat recovery equipment, such as economizers or air heaters.

For larger industrial plants where the boilers are equipped with economizers, air heaters, or both, Table 3 presents comparative parity prices for oil and coal. In these plants, it is generally accepted that efficiency will be substantially the same when burning either of the fuels. Usually, such plants have excellent combustion control systems, employ good operating practices, and follow well organized maintenance and inspection programs.

Use of the Tables

Although the tables should not be interpreted as rigid guides, they can prove quite beneficial for quickly establishing approximate price relationships among fuels. For instance, consider a modern industrial plant operating a boiler without economizer or air heater where 13,500 Btu coal is available at $9.81 per ton. For this condition, the parity price for both oil and gas can be determined readily from Table 2. First, locate this coal price below the heading of 13,500 Btu. From this point proceed horizontally to the left and read 40.71¢ per 1000 cu ft of 1000 Btu natural gas, and $2.60 per 42 gal bbl of No. 6 fuel oil with a heat value of 152,000 Btu per gal. This same horizontal line also shows parity prices for various quality coals, other types of gas, and No. 2 fuel oil.

Modification Procedures

When parity studies are required for conditions other than those on which the tables are based, it is quite easy to adjust for the differences. For example, consider a commercial installation where coal handling costs are only 65¢ per ton. Since Table 1 is based on a 10¢ per ton higher coal handling cost, all of the coal prices shown should be increased 10¢ to

TABLE 2 — RELATIONSHIP OF FUEL PRICES TO PROVIDE THE SAME QUANTITY OF HEAT AT THE SAME COST FOR INDUSTRIAL BOILER PLANTS WITHOUT ECONOMIZERS OR AIR HEATERS

Fuel oil		Gas							Coal				
No. 2 oil	No. 6 oil	Manufactured			Mixed		Natural		Stoker firing				
Estimated efficiency, per cent													
80	80	80	80	80	80	80	80	80	75	75	75	75	75
Heat content													
Btu per gal		Btu per cu ft							Btu per lb as fired				
140,000	152,000	525	540	550	600	800	1000	1100	11,000	12,000	13,000	13,500	14,000
Fuel prices													
See note*		Cents per thousand cu ft							Dollars per 2000 lb ton**				
3.3	1.50	12.33	12.69	12.92	14.10	18.80	23.49	25.84	4.35	4.79	5.23	5.45	5.67
3.5	1.60	13.15	13.53	13.78	15.03	20.05	25.06	27.56	4.67	5.14	5.61	5.84	6.08
3.7	1.70	13.97	14.38	14.64	15.97	21.30	26.62	29.28	4.99	5.49	5.99	6.24	6.49
3.9	1.80	14.80	15.22	15.51	16.91	22.55	28.19	31.01	5.31	5.84	6.38	6.64	6.90
4.2	1.90	15.62	16.07	16.37	17.85	23.81	29.75	32.73	5.64	6.20	6.76	7.03	7.31
4.5	2.05	16.85	17.33	17.66	19.26	25.69	32.10	35.31	6.12	6.73	7.33	7.63	7.93
4.8	2.20	18.08	18.60	18.95	20.67	27.56	34.45	37.89	6.61	7.25	7.90	8.22	8.54
5.1	2.35	19.32	19.87	20.24	22.08	29.44	36.80	40.48	7.09	7.78	8.47	8.82	9.16
5.4	2.45	20.14	20.71	21.10	23.02	30.69	38.37	42.20	7.41	8.13	8.85	9.21	9.57
5.7	2.60	21.37	21.98	22.39	24.42	32.57	40.71	44.78	7.90	8.66	9.43	9.81	10.19
6.1	2.80	23.02	23.67	24.11	26.30	35.08	43.84	48.23	8.54	9.37	10.19	10.60	11.02
6.6	3.00	24.66	25.36	25.83	28.18	37.58	46.97	51.67	9.19	10.07	10.95	11.39	11.84
7.2	3.30	27.13	27.90	28.42	31.00	41.34	51.67	56.84	10.16	11.13	12.10	12.58	13.07
7.9	3.60	29.59	30.44	31.00	33.82	45.09	56.37	62.00	11.13	12.19	13.24	13.77	14.31
8.8	4.00	32.88	33.82	34.45	37.58	50.10	62.63	68.89	12.42	13.60	14.77	15.36	15.95
9.6	4.40	36.17	37.20	37.89	41.34	55.11	68.89	75.78	13.71	15.01	16.30	16.94	17.59
10.5	4.80	39.46	40.59	41.34	45.09	60.12	75.16	82.67	15.00	16.42	17.83	18.53	19.24
11.0	5.00	41.10	42.28	43.06	46.97	62.63	78.29	86.12	15.65	17.12	18.59	19.32	20.06

*No. 2 oil prices are in cents per gal. No. 6 oil prices are in dollars per 42 gal barrel.

**In establishing parity prices, 50¢ per ton was added to the delivered coal prices shown to cover extra handling costs when coal is used.

maintain parity relationships with the other fuel costs. On the other hand, if actual costs of coal handling are higher than the basis of the table, the coal prices should be decreased accordingly.

If definite efficiencies of utilization are known, and they vary from the table values, price data below the headings of fuels can be easily modified. To illustrate how this alteration is made, assume a modern commercial installation where 70 per cent efficiency is obtained on a stoker fired boiler in lieu of the 65 per cent used in preparing Table 1. With this higher efficiency, the coal prices shown should be increased to maintain proper relationship with the other fuel prices. The increase should be in direct proportion to the change in efficiency, or for this particular example, all of the coal prices should be multiplied by the factor 70/65 (or 1.077). On the other hand, a decrease in efficiency below the table values means that the fuel prices should be reduced to maintain proper relationships with the other fuel prices.

By-Product Fuels

No attempt has been made to include by-product fuels such as coke oven or blast furnace gases in the tables since they are only economically available near certain industries. Then, too, when burning a low heating value fuel such as blast furnace gas, over-all efficiency is relatively low, and draft losses are high because of the large volume of gas handled. These facts are demonstrated by Table 4, which shows comparative performance data of pulverized coal and blast furnace gas.

Although problems still remain in the economical burning of by-product fuels, their utilization under boilers in the iron and steel industry is increasing. Some installations employ trifuel burners for handling variable quantities of pulverized coal, coke oven gas, and blast furnace gas. This arrangement permits convenient switching to a different fuel for part or full load depending upon price and supply of the respective fuels. Other plants use a combination of gas burners and traveling grate spreader stoker to fire by-product fuels and coal.

The parity tables presented in this article are based upon efficiencies of fuel utilization that are representative of better operated plants in each respective class. While these may be considered somewhat high for all of the fuels, it is believed that the general relationship of efficiencies is quite equitable.

TABLE 3 — RELATIONSHIP OF FUEL PRICES TO PROVIDE THE SAME QUANTITY OF HEAT AT THE SAME COST FOR INDUSTRIAL BOILER PLANTS WITH ECONOMIZERS AND/OR AIR HEATERS

No. 6 oil	Coal				
Estimated efficiency, per cent					
85	85	85	85	85	85
Heat content					
Btu per gal	Btu per lb as fired				
152,000	11,000	12,000	13,000	13,500	14,000
Fuel prices					
See note*	Dollars per 2000 lb ton**				
1.00	2.95	3.26	3.57	3.73	3.89
1.10	3.29	3.64	3.98	4.15	4.33
1.20	3.64	4.01	4.39	4.58	4.77
1.30	3.98	4.39	4.79	5.00	5.20
1.40	4.33	4.76	5.20	5.42	5.64
1.50	4.67	5.14	5.61	5.84	6.08
1.60	5.01	5.52	6.02	6.27	6.52
1.70	5.36	5.89	6.43	6.69	6.96
1.80	5.70	6.27	6.83	7.11	7.39
1.90	6.05	6.64	7.24	7.54	7.83
2.00	6.39	7.02	7.65	7.96	8.27
2.10	6.73	7.40	8.06	8.38	8.71
2.20	7.08	7.77	8.46	8.81	9.15
2.30	7.42	8.15	8.87	9.23	9.59
2.40	7.77	8.52	9.28	9.65	10.03
2.50	8.11	8.90	9.68	10.07	10.46
2.60	8.46	9.27	10.09	10.49	10.90
2.70	8.80	9.65	10.49	10.92	11.34

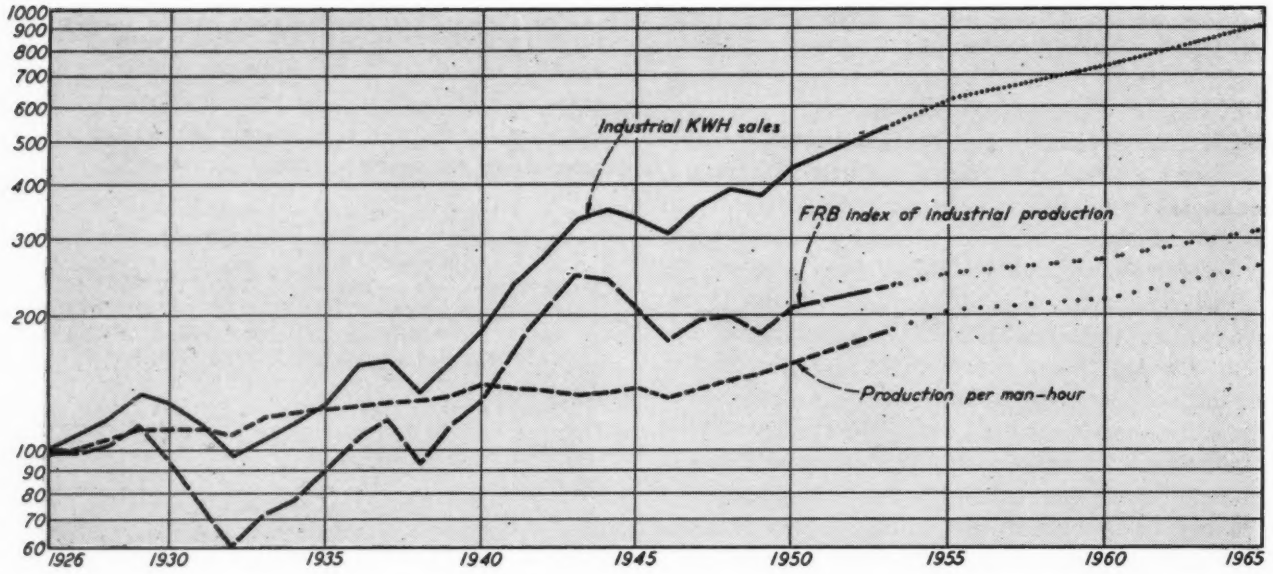
*No. 6 oil prices are in dollars per 42 gal barrel.

**In establishing parity prices, 50¢ per ton was added to the delivered coal prices shown to cover extra handling costs when coal is used.

TABLE 4 — PREDICTED PERFORMANCE DATA OF TYPICAL STEAM GENERATOR DESIGNED FOR PULVERIZED COAL AND BLAST FURNACE GAS

	Coal	Blast furnace gas
Actual evaporation*, lb steam per hr	250,000	250,000
Over-all efficiency, per cent	86.3	81.7
Excess air in gases leaving air heater, per cent	27	25
Temperature of gases leaving air heater, deg F	320	480
Volume of gas leaving air heater, lb per hr	328,000	536,000
Total draft loss through complete unit, in. wg	2.8	7.1

*Unit is designed to operate at 250 psig pressure and 500 F total steam temperature.



RELATIVE GROWTH IN THE INDUSTRIAL USE OF ELECTRIC POWER AS COMPARED WITH CORRESPONDING RISES IN INDUSTRIAL PRODUCTION AND MAN-HOUR PRODUCTIVITY ALL MADE POSSIBLE BY EFFECTIVE SYSTEM PLANNING.

Distribution System Planning

The Effects of Expected Load Growth

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The rapid and huge increases in electric power requirements since World War II have been supplied by the electric utility industry through the ingenuity of electric utility management and engineers. They have successfully provided facilities to carry the increased load on short notice rather than on a long range planning basis.

The peak electric utility load for the nation for 1952 reached the order of 75 million kw. By 1963, it is expected to be at least in the order of 140 million kw. In 20 years it may be 250 million. When the use of electric power will reach a saturation point is only a guess, but it is probably safe to say that this point will be reached only after the engineer has exhausted his ideas on further electrification to relieve the burden of daily living.

It is obvious that to supply the expected load growth of the immediate and distant future, electric utility systems must be expanded continuously. During recent years most systems have met their new peak loads with less than the desired margin in generating capacity and distribution facilities. Also, much existing equipment is old and inefficient. Many companies have not had time to make long range plans, primarily because of lack of manpower. In some quarters there is also the belief that load growth will not materialize nearly so rapidly as predicted. Therefore, in such cases it is thought and perhaps hoped that existing manpower will ultimately have time to take care of plans for greater system loads.

The most pressing technical problem now facing the electric utility industry seems to be one of adequate long range planning of system patterns for future expansion. Often there are many objections to projecting system development plans far into the future because it is not known where new loads will develop. That this should be a deterrent is unwarranted as well as dangerous. Expansion plans should be made with patterns which can be modified, as the need arises, to supply load growth in any area of a system. By having such plans, each change in existing equipment and circuits as well as new additions can be made with the knowledge that the work is directed toward an ideal even though the ideal is never actually attained. Today, as a matter of fact, locations for generating stations and right-of-way for high voltage transmission circuits are dictated to a large degree by factors other than where the next heavy loads will develop.

It is fundamental that there must be an electrical circuit between the generator and the consumer. The problem then is to get from the generator to the consumer with a minimum of investment but with assured reliable service. To bring out some of the factors involved in planning for expanded power sys-

tems, it is well to review the over-all system and some of its component parts.

Over-All System

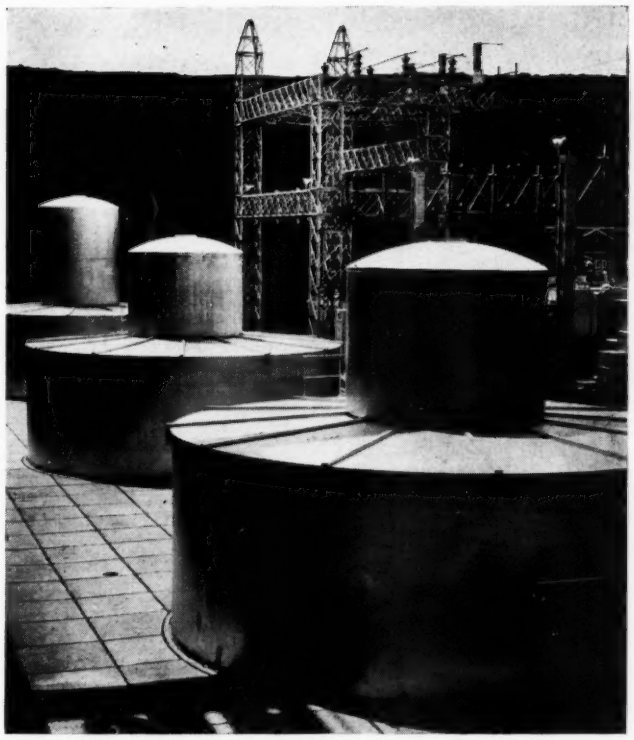
Because of the fact that neighboring electric power systems have been tied together through high voltage circuits, a smaller area reserve in generating capacity is possible. In other words, a particular company now works with a power pool or group of companies within a given area, and leans more heavily upon the smaller generation reserves of each company through tie lines which can be used in the event of an emergency. This must be exploited to the fullest.

Another significant development is the installation of high voltage underground cables to bring large blocks of power into congested, heavy-density load areas. This has been done at 69, 115, and 138 kv and more must be done. This is expensive to the power companies, and in some cases probably could have been avoided in the past. It may be avoided in the future by securing rights-of-way for overhead transmission at an earlier date.

It is very encouraging to note that utility engineers are now thinking that some agreement should be made with respect to the next higher system voltage or voltages, and that as far as possible neighboring companies should use the same voltage so that power flow, particularly during severe emergencies, will not be limited by transformers. Few, if any, companies have ever regretted going to a voltage higher than that which they could economically justify at the moment.

Higher distribution voltages are being used in many areas, and the planning engineer must look far ahead on this subject. It is often difficult to justify changing from a low distribution voltage, such as 4160 v, to a higher voltage in a given area. Nevertheless, this has been done in some places with considerable satisfaction on the part of the companies which have taken the step. In other areas which have been expanded and new loads developed, higher distribution voltages in the order of 13.2 kv have been used with success. Some distribution circuits are now operating at 24 kv. In many cases, the load per feeder at the higher voltages is substantially more than that which was used on the lower voltage circuits. This has been done in spite of the fact some operators claim that no more than 3000 kva of load should be dropped in the event of a circuit outage. Those companies using the higher distribution voltages do not seem to have any particular objection to dropping a larger amount of load in the event of trouble because service is restored fast enough to prevent serious troubles for their customers.

Prior to the war, distribution systems represented roughly 55 per cent of the total system investment. Since the war, distribution systems have received between 35 and 40 per cent of the new money. This does not mean that distribution has been neglected, but rather that more of the reserve in existing circuits has been used up. It appears, for this and other reasons, that the distribution system must receive more attention in the future to efficiently and economically supply imminent increases in load.



TYPIFYING RECENT TRENDS TOWARD OUTDOOR GENERATING STATIONS ARE THESE MACHINES OF THE IDAHO POWER COMPANY'S BLISS PLANT LOCATED ON THE SNAKE RIVER.

Generation

Sites for power plants are dictated to a large extent by the availability of cooling water and to a lesser degree by the proximity of fuel. Because of the water situation and congestion, many plants are now being built at points remote from load centers. This means that more high voltage transmission lines must be used. Generating units are getting larger almost by the month. About a year ago a single shaft, 3600 rpm, 200,000 kw machine was sold to a large utility in the East. Today 300,000 kw, 3600 rpm, single generator units are being considered. With improved designs, better cooling techniques, and better insulation, these larger units use less material per kilowatt of rating, are smaller, and can be placed in a building costing less per kilowatt of capacity than heretofore.

Also, in many parts of the country, outdoor generators are being installed, usually with a very simple enclosure over part or all of the machine, with a movable crane for handling the turbine and generator parts. In these outdoor plants the boilers are not enclosed in buildings, but are exposed in a manner very similar to oil refineries. There are a number of outdoor power plants that are acceptable in appearance because all parts of the plant, piping, structural

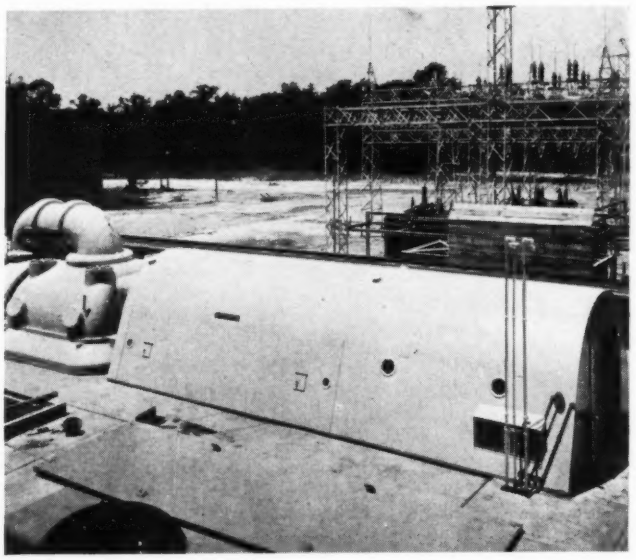
steel, boiler siding, foundations, generator, and everything are painted the same color. It is believed these outdoor plants have a more acceptable appearance than an oil refinery plant. Certainly there must be a saving in investment for power plants which are of the outdoor variety as compared to those enclosed in buildings. Perhaps more can and will be constructed of the outdoor type.

Because of the economies associated with the use of larger generator units, the system planning engineer is forced to determine the proper balance between investment in generating facilities and in transmission facilities. Not only is this important for a particular company, but it is important from an area standpoint in which reserves are pooled to attain minimum investment on an area basis. Such area planning as this must be done on a long range basis, perhaps covering a ten-year period or longer, and as each additional element is added, its effect on the over-all plan should be evaluated and the master plan revised if necessary.

High Voltage Transmission

It is believed that the future high voltage transmission system will consist of large grids, each embracing large areas of the country at one voltage. This will be dictated from a national defense standpoint, from a reserve standpoint, from a catastrophe standpoint, and recognizing all of these factors, from an economic standpoint. Thus each operating company should look far ahead today to evaluate the power needs of each area when the load doubles, triples, and perhaps even quadruples. As an example of this type of thinking, the initial 230 kv systems were installed on the West Coast area looking ahead for 20 or 30 years. Today these same systems are looking at voltages as high as 440 kv with the idea that they also will supply their transmission needs for another 20 or 30 years. This may be fantastic thinking, but the loads which will have to be supplied in the future are also fantastic. Cahen of France has predicted that system voltages of the future will get into the 700 to 800 kv class!

Obtaining rights-of-way for high voltage lines is becoming increasingly difficult. Therefore, it seems logical that future needs must be anticipated, plans made, and rights-of-way purchased in order to more economically supply future loads. The day has already passed when additional high voltage overhead circuits can be built into most congested areas. Thus, many companies are forced to install high voltage underground cable into heavy load areas to supply increased power demands. By long range planning, perhaps many such situations which will unquestionably develop in the future can be supplied by overhead rather than underground circuits. Where underground circuits are required, however, it is not a matter of whether or not it can be afforded, but simply a matter of necessity.



OUTDOOR CONDENSING REHEAT TYPE TURBINE AND GENERATOR OF THE CAROLINA LIGHT AND POWER COMPANY'S GOLDSBORO STATION, RATED 62,500 KW AT 3600 R.P.M.

If long range planning is not done, existing voltages usually are expanded as the need arises with the result that a time comes when a much larger over-all investment must be made, some of which might have been done much earlier. It might be stated that basic plans are seldom changed by looking just two or three years ahead.

Switchgear

By long range planning, most existing high voltage circuit breakers can be used in locations where their interrupting kva is not exceeded. If a system is just allowed to grow, breaker interrupting capacities are often exceeded and they must be replaced by higher capacity and more expensive equipment. By careful advanced planning of additions to a system, only the newer installations will require breakers of higher interrupting capacity for the most part. Breakers of 10 million kva interrupting capabilities are now available at 138 kv and above, and by proper application their use will limit the number of transmission circuits required and make for over-all system economy.

For 230 kv and higher, breakers having 15 million kva interrupting capabilities are now being designed. There is a very definite trend in this direction because higher capacity breakers can be applied to advantage rather than subdividing the backbone grids which requires more transmission circuits. The system planning engineer should recognize this fact as even the largest high voltage circuit breaker can be obtained and installed for what it costs to build two or three miles of high voltage transmission circuit.

Regarding lower voltage circuit breakers for expanded systems, careful planning and the proper use of transformer sizes will limit the interrupting duty

on circuit breakers and thereby keep to a minimum the investment in these devices. Controlling short circuit kva is a problem which has been overlooked in many instances, and when finally realized, extreme and costly measures had to be taken.

Transformer reliability has been proved in actual performance on systems, and a higher quality product is assured by surge testing prior to shipment. Here again the system planning engineer has to evaluate the characteristics of new types of transformer cooling. Forced cooling techniques applied to transformers result in a smaller, lower cost product, and the transformer impedances can be selected to minimize short circuit kva for breaker application.

The limitation on transformer size is one of how large a unit can be shipped. Three-phase units in excess of 200,000 kva are now being manufactured, and larger units can be built with present-day improved materials and design practice.

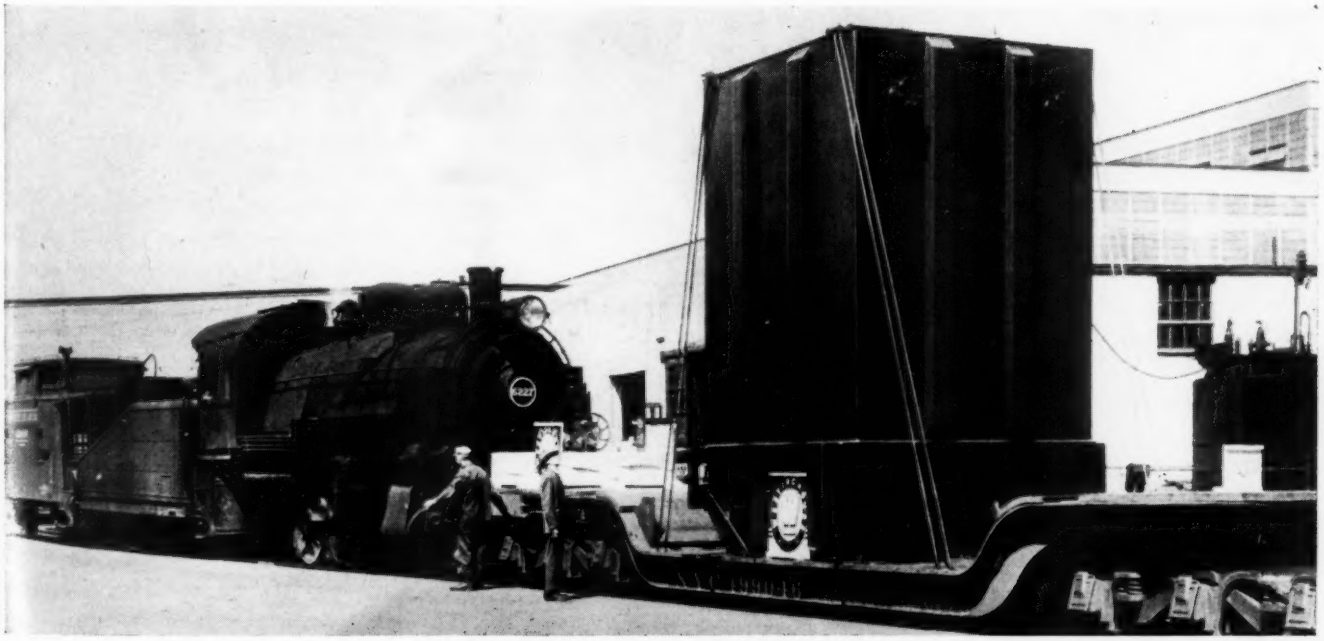
When transformer banks in excess of about 250,000 to 300,000 kva at 230 kv are required, they probably will be provided in three single-phase units because of shipping limitations. Likewise, at voltages higher than 230 kv and at ratings of probably in excess of 200,000 kva, single-phase units must be supplied.

The matter of insulation levels to be used in high voltage transformers (and circuit breakers) and how the insulation is protected is of tremendous importance. Evaluation of past performance and theoretical studies should be done on a realistic basis before large scale applications of equipment are made with greatly reduced insulation levels.

It is very evident that many systems in the 69 through 138 kv classes, will be called subtransmission systems in the future. Even some 230 kv systems may be classed as subtransmission. These circuits will fit into a pattern very similar to the pattern now in existence for voltages between 13.8 and 46 kv inclusive. This point should be recognized by the system planning engineer. Perhaps many of the 69, 115, and 138 kv systems will have to be broken up and tied into a higher voltage system at appropriate points in order to limit the short circuit kva on existing breakers and to enable the relay engineer to do a proper job of selecting and clearing faulted circuits.

The distribution system has the greatest number of variations, and it is most difficult to arrive at arrangements which can be agreed to by a large number of operating companies and distribution engineers. One major reason for this is that the standards of service are different in various areas. Therefore, it would be a great step forward in the industry if some general agreement could be established on this question. By establishing standards of service, a great deal more standardization in equipment could be accomplished, thus reducing system investment. As an example, many operating companies feel that they should not have more than about 2000 kva on a particular circuit. Others say that 5000 kva or even more can be handled very satisfactorily. If the 5000 kva or higher figure could be used, then it is believed that voltages in the 13.2 kv range have an economic edge over those in the 4 kv range. From an economic standpoint, the higher voltages must supply more load per feeder.

During the past few years there has been a very definite trend toward the use of unit substations on distribution systems throughout the entire country. These are so-called standard units; it is believed there are still too many ratings in order to achieve



PHYSICAL SIZE LIMITS THE RATINGS OF SYSTEM COMPONENTS BECAUSE OF SHIPPING CLEARANCES. THIS UNIT IS STRIPPED OF ITS BUSHINGS AND COOLING EQUIPMENT WHICH ARE INSTALLED AT THE CUSTOMER'S SITE.

maximum economy in manufacturing as well as in application. Maybe there should be only two or three sizes of transformers supplying 5 kv class circuits. Perhaps one or two sizes for multi-feeder substations, and one or two sizes for single feeder substations would be adequate. Similarly, we should have a reduced number of transformer sizes for other higher voltage distribution substations. Serious consideration should be given to reducing the number of distribution and subtransmission voltages.

Other Factors

It is believed that the system planning engineer, with his distribution engineers, can work out arrangements whereby increased loads can be supplied using a fewer number of sizes of units with ultimate over-all economy. Locations should be selected and purchased in growing load areas in order to put in additional substations when the time arrives. This seems to be one of the critical problems in distribution systems today, and it might well be that substation units will have to be enclosed in buildings which blend with other buildings in the area for the sake of appearance.

The planning engineer also has the problem facing him of whether or not three-phase distribution services should be established. This is undoubtedly imminent in certain areas of the country, particularly where air conditioning (heat pumps) will be installed. In this same connection the question also arises should 120/208 be continued as a distribution voltage. It appears that the present voltage will continue, particularly since our merchandising channels are through hardware stores and dime stores, on electrical devices usable on 120 v circuits.

A distribution system grows in two ways, one as an increase in density in existing areas, and the other as a growth in area. To cover these two situations, the system planning engineer should establish a flexible pattern which will allow for growth in any direction and in any magnitude in a given area in order to supply future loads. This point cannot be overstressed because so many planning engineers feel that they must know the exact location and amount of increased loads before they can make plans to supply it. If a desired system pattern is established, the existing system can grow into it as modifications are made. In a period of 20 years, a desired system may be obtained.

To supply the power loads of the future will require more and bigger generators, larger transformers, higher interrupting capacity circuit breakers, higher transmission voltages, probably higher subtransmission and distribution voltages, and more serious consideration to the matter of standardization of service and equipment. In addition, there are many other factors which affect a good long range system plan. One of the most important is the matter of system protection, particularly relaying. The system should be designed so that only that part in trouble is removed, thus allowing the remaining good portion to carry the load. Proper lightning protection of transformer windings and rotating equipment should be a matter of careful planning. Remote control of more substations and plans should be given careful consideration. Carrier and microwave systems for communication, relaying, telemetering, and supervisory control have a definite place in future planning for efficient system operation.

Industrial television undoubtedly will take place in the power system operation so that operators can remotely view smoke from the stacks, fires in the boilers, ashes in the boiler pits, coal handling facilities, meters in remote stations, and gates on a hydro system.

The system planning engineer must also work out means of controlling voltage levels throughout all parts of the system on a coordinated basis. This problem is particularly of great concern as higher voltage transmission lines are installed and as more high voltage cable is added to a particular system.

Allied to the problem of appearance is the one of noise; this has been a subject of discussion in recent years, particularly as associated with transformers. This again is a matter of standardization, and it is believed that perhaps two standards may prove to be desirable, one for areas where noise is not a factor, and another for locations in which a low noise level is desired.

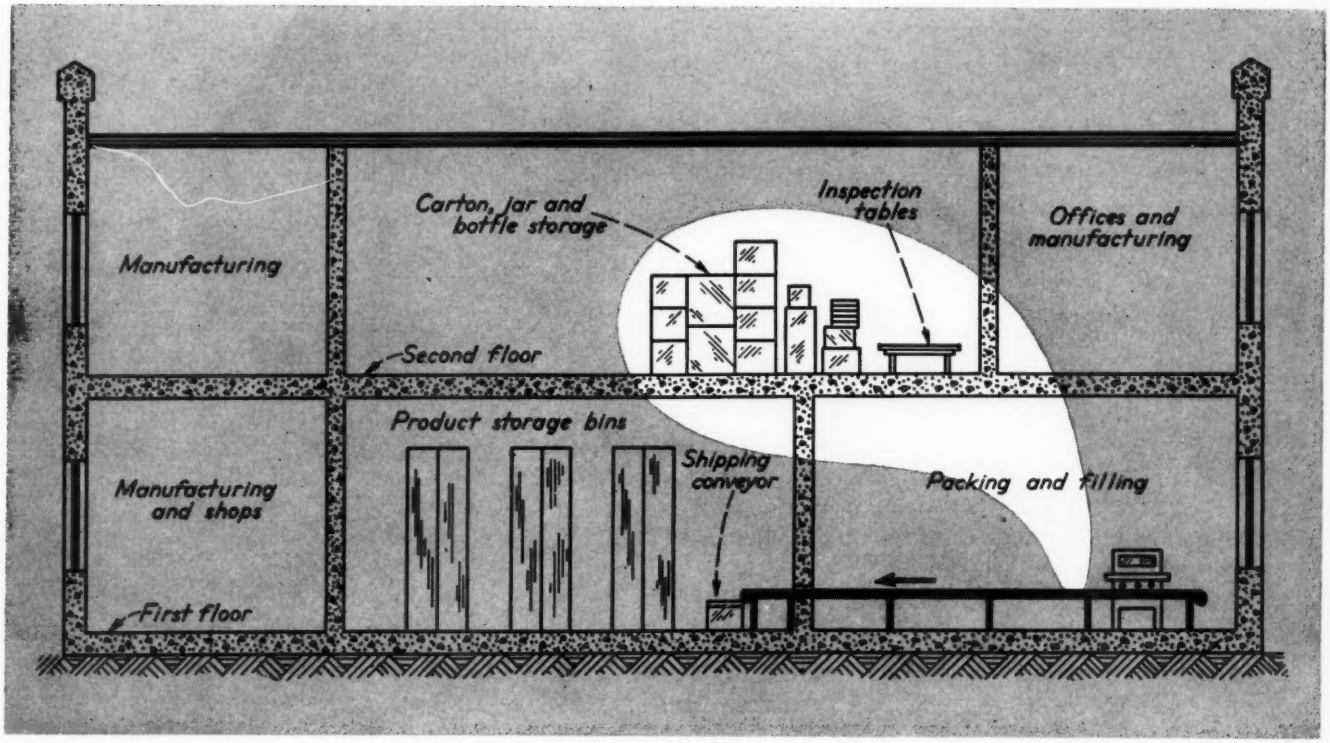
In some areas the system planning engineer is also going to be faced with the problem of putting distribution facilities underground. Some work has been done in this direction in suburban areas although there is no real trend because of the much higher cost of installing such facilities underground as compared to overhead.

Summary

To properly plan for the future, the following general rules seem to apply:

1. Prepare an ideal, long range (ten years or more) system plan for the area involved.
2. Make a system plan which embraces the key equipment and facilities already in existence.
3. Determine on a step-by-step, or year-by-year, or maximum load basis how the facilities in existence can be fitted into the ideal plan.
4. When each change or addition is made to the system, make it in such a way that it fits into the ideal plan.
5. Modify the ideal plan on a year-by-year basis so that it more nearly matches presently indicated load requirements.

Above all, the ideal system pattern must be flexible and allow load growth at any location in almost any amount. The adoption and use of an ideal long range plan will give much better results than a system pattern which develops on a short term basis.



THE PROBLEM—MOVE THE CARTONS, JARS, AND BOTTLES OUT OF STORAGE AND DOWN TO THE PACKING AND FILLING AREA.

Step by Step Solution To a Materials Handling Problem

By
SIDNEY V. WORTH
Lever Brothers Company

A good engineer considers many angles when faced with a technical problem. Only by comparing possible solutions does he find the right answer.

In this industrial plant, collapsed cartons, carton spaces, fillers, jars, bottles, and cans are stored on the second floor of the two-story building. In this area employees inspect the containers and assemble the cartons, after which both cartons and containers must be delivered to a packing and filling area on the first floor. Containers are automatically filled in a filling machine, then packed in the cartons and delivered to a shipping conveyor, which runs through a product storage room to the shipping department.

The Problem

The materials handling problem consists of finding the best way to get the containers and cartons from their second floor storage and inspection area to the packing and filling department. The first three solutions illustrated were suggested, appraised, and then rejected for various reasons. The final solution, illustrated in Fig. 5, was adopted as the most economical and efficient of those considered.

Alongside each illustrated solution is a list of equipment and operating labor requirements. The estimated cost of equipment includes cost of installation in each instance. No value is placed upon operating labor, but it might be estimated at perhaps $2800 per year, as this is strictly unskilled labor in every instance.

The Solutions →

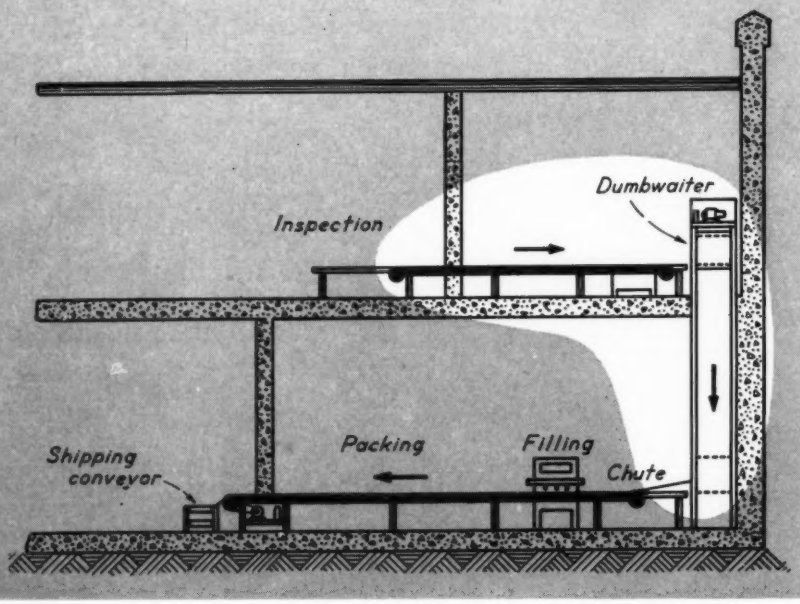
Equipment and Installation

2x3 ft dumbwaiter	
500 lb capacity	$1500
12 in. conveyor belt	
2nd floor	$1700
Total	$3200

Labor

1 man to load dumbwaiter on 2nd floor

1 man to unload dumbwaiter



Solution 1—Above

The first solution to be considered calls for the installation of a dumb waiter. Cartons are assembled and inspected on the second floor in the storage area. The cartons and inspected jars and cans are then stacked on trays, placed on the dumb waiter, and lowered to the first floor. Jars and cans are chuted to the filling station while the cartons are sent along the belt conveyor, pulled off and filled by packers, and then loaded back on to the belt, which delivers them to the shipping conveyor. This arrangement requires the use of an extra man on the second floor to load the dumb waiter and another man on the first floor to unload it. Not only is labor cost excessive, but the first cost of the equipment is high.

Solution 2—Below

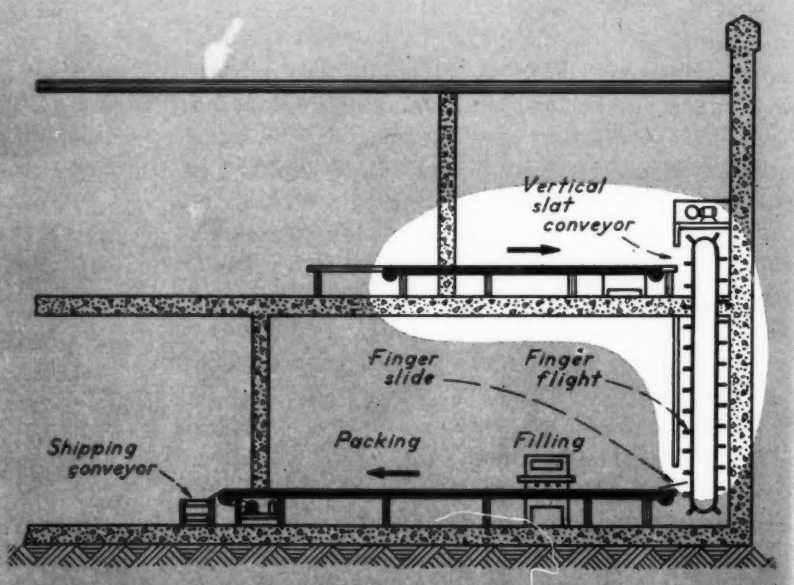
It is obvious that handling costs are too high with a dumb waiter installation, so consideration was given to means of speeding up production and decreasing the amount of handling. It was suggested that a vertical slat conveyor having rod fingered flights be used in place of the dumb waiter. By using a rod fingered slide at the first floor level, jars and cans on the flights are picked off automatically. Assembled cartons cannot handle this type of equipment, so they are trucked to the packing line where they are loaded with containers and placed on the horizontal belt leading to the shipping conveyor. It is estimated that this method will reduce, by one-half a man, the labor required for the operation.

Equipment and Installation

Vertical slat conveyor, one flight in 3 ft.	$1800
Automatic loading device	$1000
12 in. conveyor belt 2nd floor	$1700
Total	$4500

Labor

½ man supplying cartons to 1st floor

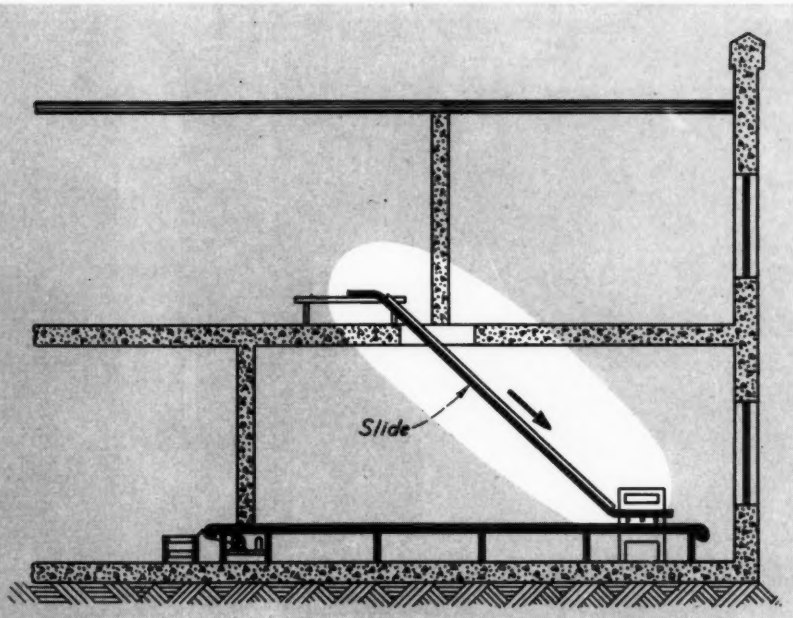


Equipment and Installation

Stainless steel jar chute	$800
Total	$800

Labor

½ man supplying cartons to 1st floor



Solution 3—Above

Here is a completely different approach. It is a simple chute leading from the container storage and inspection area directly to the filling machine. This chute is designed to handle jars or cans only and it is covered with a hinged wire grill cover which permits inspection and cleaning, but prevents any containers from jumping out. The cartons are trucked to the packing area just as in Solution 2. This design appears to have several advantages over the conveyor or dumb waiter system. The chute does not take up any space in the office or manufacturing area.

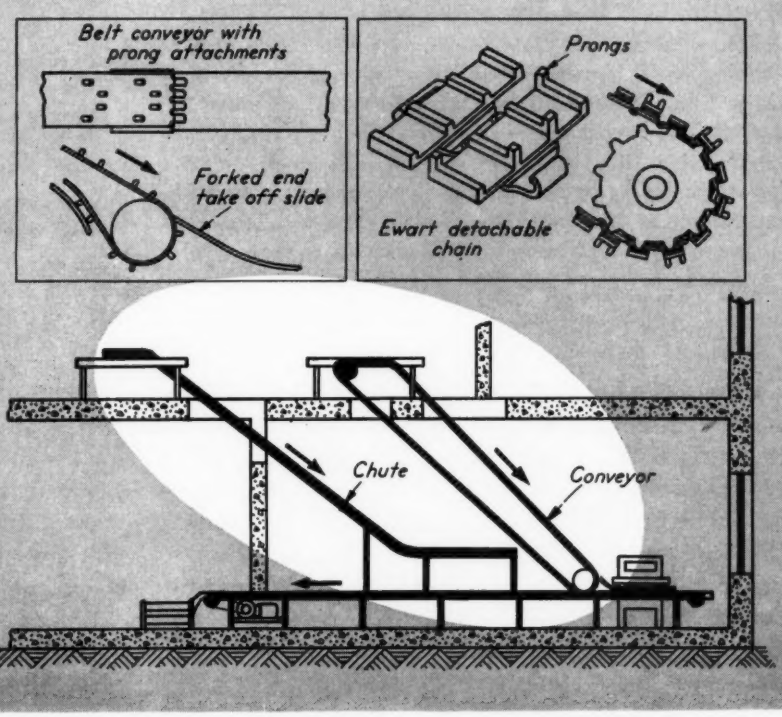
Solution 4—Below

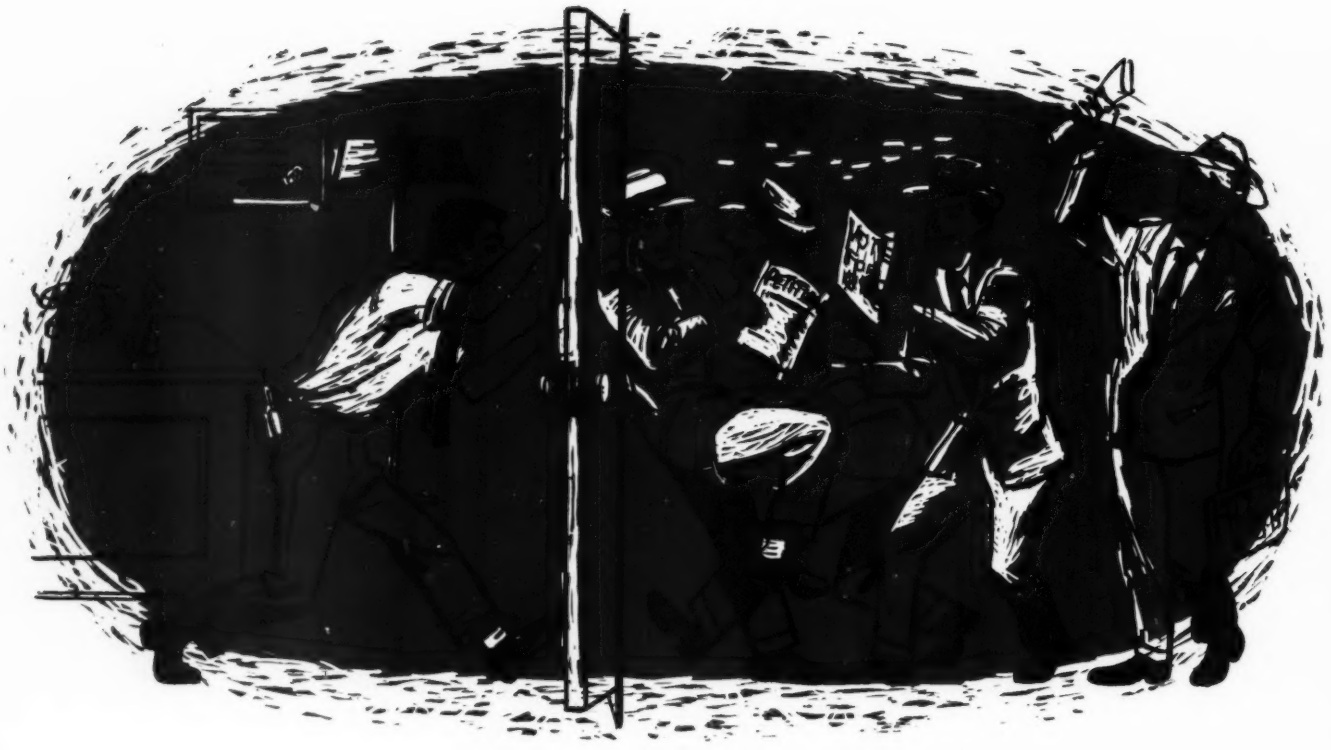
The simple chute of Solution 3 is inexpensive, but it did not do the job. Jars jammed, crashed together, and breakage was excessive. All of the chutes disadvantages were overcome by designing a powered conveyor belt with prongs arranged to nest the containers. A notched slide delivers the jars from the belt to the filling machine. A slider bed is used to guide and protect the return travel of the belt.

An Ewart chain may be used instead of the belt, every other link being cast to form a rest for the jars; it wears longer, and requires less maintenance.

Equipment and Installation

4 in. sloped belt conveyor	$1200
Steel chute for cartons	$ 250
Total	$1450
Ewart chain sloped conveyor	$1450
Steel chute for cartons	$ 250
Total	$1700





Engineers Should Stick to Engineering

By FREDERICK H. McDONALD

If Mr. McDonald really believes as he argues in his article, he is the type who asks that you do as he says, not as he does. For Mr. McDonald, himself, has been most active in civic and political affairs. Not only is he a past president of his Rotary Club, but he is now chairman of the Board of Architectural Review for Alterations and New Structures in Old and Historic Charleston. He is a past director of ASCE, a member of the American Institute of Consulting Engineers, St. Andrew's Society, Huguenot Society of S. C., and the Carolina Yacht Club — all in all, a "joiner" and a clubman to a degree rarely encountered among engineers.

Professionally, he has been on projects ranging from the Atlanta Union Station to a half-dozen theaters and a power plant. Since 1939, he has been in Charleston as a consulting engineer in community and industrial development.

The author of this article, Frederick H. McDonald, takes a position opposite to that of most engineering societies. During the past few years many of the societies have set up special committees, such as the ASME Committee on Civic Responsibility. National, regional, and local organizations have worked hard to promote the idea that engineers have civic responsibilities and should take an active part in politics and civic betterment work.

This, says Mr. McDonald, is all wrong. Engineers in politics, or in any of the social sciences, are fish out of water. They accomplish nothing and destroy their own usefulness.

The editors disagree with Mr. McDonald, but we admit he has taken a stand which can be well defended. It can also be refuted, we believe, with both logic and example. We will welcome discussion by readers. Ed.

The engineer has gained the full confidence of the public by demonstrating his capacity to determine facts, analyze them, and arrive at conclusions that prove themselves in performance. Businessmen and civic leaders so value these abilities that they engage engineers on countless kinds of problems.

These clients see the engineer functioning as a rationalist, unswerved by prejudice, emotion, or personal interest. These are the qualities of a professional man. These, along with his store of technical knowledge, are the qualities which lead the public to accept an engineer's decision on the safe footings for a steel tower . . . on boiler pressures . . . on the economic selection of alternate structural and operating solutions. Businessmen and civic leaders will risk their reputations and their dollars on this kind of judgment.

What happens when the engineer substitutes for the businessman or the civic leader? What happens when he gets out of the realm of factual determi-

nations, to deal with the emotions, prejudices, and personal interests of human beings? Here neither the facts nor the predictable processes of mechanics or chemistry can help. Here are neither formulas nor laboratory dicta. Here the controlling factors are neither rationally nor scientifically measurable.

Here, I believe, the engineer is out of his medium. My observation is that human relations is not the natural field for the typical engineer and that even socially the reading, study, and absorption in a specialty that makes the engineer a guaranteeable bet in his profession are quite likely to make him a one-track conversationalist and even a problem at a party. I never will forget the year I worked on setting up a municipal pilot test with one of the pioneers in the chemical treatment of sewage effluent. How my family pleaded with me to find some way of avoiding the subject at the dinner table when we had him and other guests in for an evening! Yet we loved him for his courage in plowing new furrows and for his nightly devotion to the tomes and worksheets by which he adjusted each day's findings to his vision of new potentials for the citizens and businesses of many communities.

The engineer's steady contribution to human productivity and to the public's welfare in his normal work raises the question of how, if at all, he should attempt to double in brass. Particularly am I convinced that the constant emphasis on the engineer's duty to assume leadership in civic, state and national affairs needs reconsideration.

Where is the proof for the repeated implications from within the profession that its members are derelict in not personally leading their fellow citizens to see and use the truths the engineer is capable of determining? Here his critics depart from their evidence-guarded determinations to presume that the engineer will be equally able to exercise a specially required judgment in a field foreign to his instincts and his training.

I have seen this leadership offered with disastrous results to engineers of unquestioned capacity and sincerity. Here are but two instances from a number of observations. In the first I will clothe one of my best friends with an assumed identity.

John Currie is in private practice in Blankton. Ten years ago he was visited by a committee of the Merchants Association. The city, to meet an emergency deficit, had announced an arbitrary raise in the business license taxes for the ensuing year. No discussions or hearings had been offered by the administration. The merchants thought the tax change a hasty stop-gap and unfair. They wanted a thorough study with findings reported in two weeks, to see what could be done in the thirty days before the new taxes would become effective.

Currie was the man for the work, involving a factual and comparative study of some 2000 applications of the tax in use. His findings showed that the increase would be grossly inequitable in many categories of business and the professions; that it would not reach some at all.

Currie's report was acclaimed and duly presented by the committee of the Merchants Association to the mayor, who passed it on to the chairman of the finance committee which had originated the license increases. The next day the finance chairman made a public defense of the new license scale. He charged that the members of the Merchants Association were seeking personal preference. He also distorted the facts and findings of the report. The president of the association begged Currie himself to issue a correction. This Currie did in an interview with a reporter. His statement was confined to the facts and was correctly reported. But the press had been severely critical of the administration's policies; and the newspapers for two days gleefully carried headlines on the general theme that "CURRIE SINKS FINANCE CHAIRMAN IN SIZZLING REBUTTAL!"

The tax was rearranged in cooperation with the Merchants Association and other group representatives just as Currie's report suggested.

The chairman of the finance committee later became and still is mayor. Currie has been blacklisted for any work in which the city has a say.

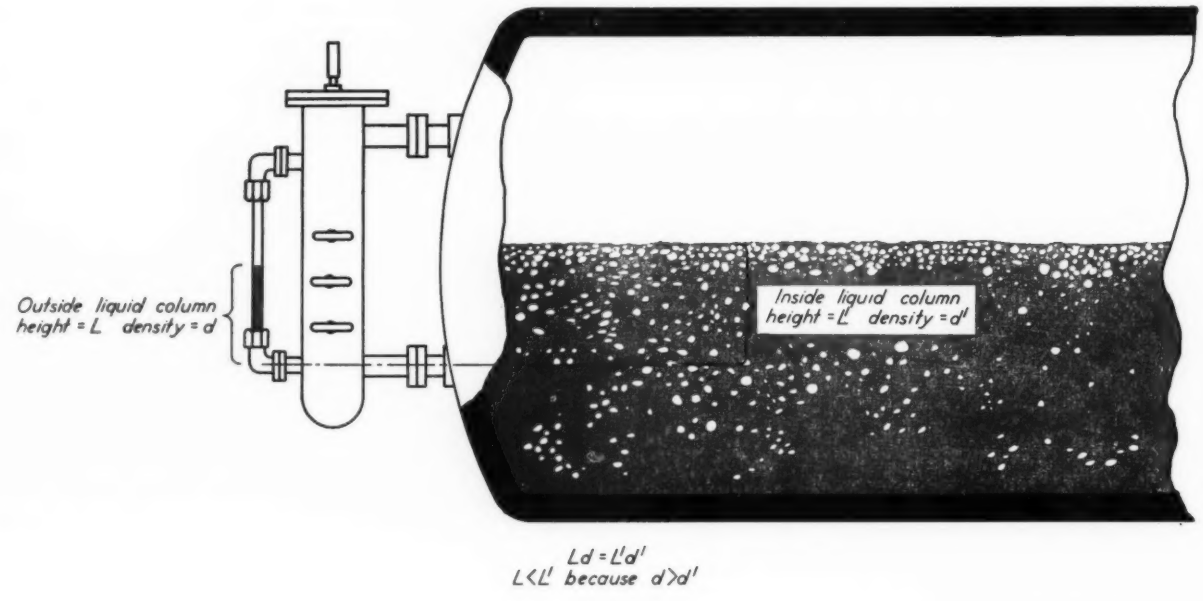
The businessmen who are the civic leaders of Blankton are fully aware of this enmity. They know it reaches into far corners of the community. They have not in years used Currie's services for their business or civic problems on which they know he has special capacities because, as one of his former clients frankly told him, "We have two strikes against us when we use you."

The other illustration is in the remarkable favorable public and political reception of Herbert Hoover's factual and advisory study on governmental reorganization. Contrast this with the public and political disregard of his equally capable and sincere recommendations for governmental action in the last year of his services as president.

John Currie stepped out of the role of fact-finder and advisor, to be played up as a partisan leader. Hoover, as an engineer, as Director of European Relief, as Secretary of Commerce, won the confidence of the nation. As president he was treated as a partisan leader by Congress and the people when they became panicky from the bursting of their own bubbles. No one then was seeking the clinical remedies of engineering. The people wanted consolation psychology. Roosevelt dealt in this commodity. But it took nearly twenty years for the American people to see the truth and welcome Herbert Hoover back into their confidence—as an advisor.

If this distinguished engineer had had to earn his living, as John Currie does, in the darkened years of his misinterpretation, his integrity as an engineer and as a sincere leader in the people's interest could have cost him plenty.

SKETCH SHOWS INSIDE LIQUID LEVEL IS ALWAYS HIGHER THAN OUTSIDE INDICATION WHEN UNIT IS STEAMING



Significance and Control of Water Level

A. R. MUMFORD, Research Department
Combustion Engineering-Superheater, Inc.

Albert R. Mumford graduated from Massachusetts Institute of Technology in 1918. After four years as assistant fuels engineer of the U. S. Bureau of Mines he joined the New York Steam Corp. as research and design engineer. From 1938 to 1942 he served as assistant director of research with the Consolidated Edison Co. of New York and then joined the research department of Combustion Engineering-Superheater Inc. Mr. Mumford has directed the work of the ASME special research committee on furnace performance factors, the reports of which form an important contribution to engineering literature on heat absorption by boiler furnaces. He was vice president of the ASME from 1946 to 1950.

Young men just entering the power plant field of the engineering profession accept the name "water level regulator" as descriptive of an assembly of equipment which is designed to control the water level within a boiler between specified limits. It is unfortunate, perhaps, that these young men have not been familiarized with the fact that a water level regulator was first developed to protect the boiler from loss of water or from flooding when the fireman was preoccupied with his many other duties. Actually, a water level regulator in its simplest form is designed to control the flow of feedwater into the boiler. This function it performs with precision and success as has been demonstrated by innumerable satisfactory installations.

The regulating valve is, of course, external to the boiler and responds to one or more impulses transmitted to it from devices influenced by the density of a column of the fluids in the drum, by the flow of the vapor out of the drum, and by the flow of the liquid into the drum. The relative importance or bias of each influence on the operation of the regulating valve can be adjusted to produce the desired effect of the operation of the assembly according to existing local conditions. Obviously, however, an external control cannot have any direct effect on the internal

fluid conditions of the steam generator. No control, known to the writer, makes any attempt to remove water from the boiler but simply adds water according to a summation of one or more of the three influences mentioned.

Once water has passed through the regulating valve, its effect on the liquid level is beyond the control of the assembly. Any attempt to remove water from the generator automatically because of a sudden change in operating conditions would involve the degradation of some energy which would adversely affect the cycle efficiency. However, operation of blowdown valves by hand is common practice when a unit is starting up to avoid any bad effects from too high a level during initial operation. Even under variable loads a good regulator will maintain water level at the desired average value over a period of time, but a better understanding of the influences which affect the fluids within the steam generator beyond the control of the regulator, will clarify the significance and control of water level.

The usual water column and gage glass at the end of a boiler drum balances a visible column of steam and water in the glass against an invisible column within the drum. The liquid in the glass is cooler by a measurable difference than the mixture within the drum and must, therefore, be denser. The vapor in the glass is also slightly cooler and is condensing, but the difference in density is small enough to be neglected under normal conditions of installation. It is apparent, therefore, that the indication in the glass does not correspond to the liquid level, if it exists, within the drum but is lower. The correlation between these two densities or levels is reasonably constant at a given load, and the visible level always is an assurance that the internal equivalent is at least that high in the drum.

No attempt is made, except during special investigations, to balance an external column of liquid against the internal column of liquid and vapor over the height of the generator. As steaming begins, the "swell" is the usual indication that a considerable portion of the inside column is vapor. This proportion of liquid and vapor is changing constantly even under conditions considered as steady load. Under ideal load conditions, the mean density of the internal column for the whole height of the steam generator would be constant. Thus, the gage glass indication, influenced by only part of the drum diameter, tells nothing of what is going on in the remaining height of the steam generator. To learn of the other factors special investigations must be made or inferences drawn from related observations.

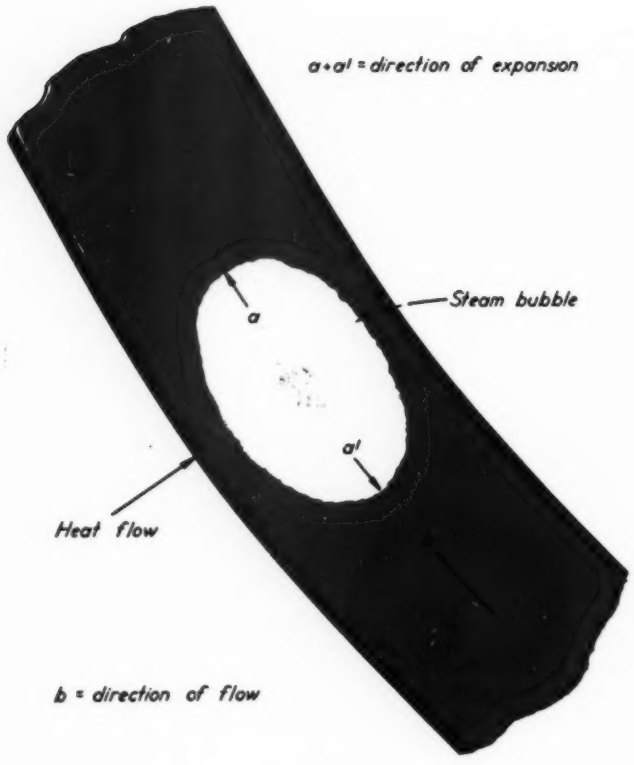
Water level control problems are very minor and of little interest under normally steady load conditions, while at very constant load no problem exists at all. Water level control is, however, of great interest and of prime importance when the load is varying. Fortunately, the difficulty of the problem is influenced favorably by increasing design pressures because the expansion ratio from liquid to vapor decreases with increasing pressure or, in other words, the difference in density between the liquid and vapor decreases. In most industrial applications and in the older utility boilers, now used for peak load supply, loads are not constant and steam pressures are low enough to produce an important expansion ratio. Such applications are quite interesting and study of the reactions occurring leads to an understanding of the problem.

As a boiler is heated preparatory to bringing it on the line, circulation starts before steam is generated because of the difference in density between the heated riser leg and the colder downcomer leg when free communication is available in the drum. Although circulation velocities are modest under such conditions, the circulating fluid serves to bring the metallic parts of the unit up to saturation temperature and thus avoid the temperature stresses due to inequalities. As soon as the fluid reaches the saturation temperature corresponding to the existing gage pressure, steam will form and the density differences promoting circulation will be multiplied. For each rate of heat input there is a normal circulating velocity which is fixed by: (a) the resistance of the circuit, and (b) the net difference in density between the riser side and the downcomer side.

At any constant heat input, a balance between the circuit resistances and the available head is reached rapidly so that the water level remains steady with uniform flow of feedwater. However, when any change is made in heat input all of the factors involved in the circulation velocity change and new equilibrium values are set up. In addition, the acceleration or deceleration of the fluid velocities requires the momentary development of forces which must be reflected in the circulating head.

With a rapid change in heat input or load, the amount of vapor below the water level must change before the accelerating forces can be available. With the expansion of liquid to vapor acting linearly in both directions, the flow of liquid into the circuit may be slowed down, stopped, or even reversed according to the severity of the change (rise in this case) in heat input. The accelerating force also has an equal and opposite reaction which momentarily retards the circulation. Thus, on a sudden increase in load, vapor will accumulate below the water line from the instant the heat input increases to the time the circulation velocity has been accelerated to its new value. The difference between the volume of the vapor and the water from which it was formed causes a displacement of water into the drum which is the characteristic "swell" of a sudden increase in load.

As soon as the circulation velocity has accelerated to its new value, the water level returns to a height usually slightly above normal, thereby reflecting the somewhat larger amount of vapor beneath the



EXAMINATION OF THE ABOVE ILLUSTRATION REVEALS:

With expansion of liquid to vapor, expansive forces in direction a' oppose flow.

With increase (or decrease) in number of bubbles, flow is increasingly resisted by expansion of liquid to vapor.

With increase in number of bubbles, forces required to accelerate flow react equally against flow.

water level at the higher load. The momentary rise in water level provides the additional differential head required to accelerate the fluid to the new velocity. This rise in water level although largely due to displacement of water by the increased formation of vapor is also partly due to the slowing, stopping, or reversing of the flow of liquid out of the drum into the downcomers.

The "shrink", or dropping of the water level, during a sudden decrease in heat input or load is, of course, a reversal of the order of events occurring during an increase in load. When circulation velocity is decreased, the amount of vapor below the water level is decreased, and the decelerating force must be applied. Momentarily these events result in a drop in the water level which will stabilize at a somewhat lower than normal value if operation is continued at the low load, this time because of the decreased proportion of vapor below the water level.

Obviously, all of the foregoing changes in circulation velocity, volume of vapor below the water line, and accelerating or decelerating forces are in response to changes in heat input and are beyond the control of the feedwater regulator. In cases of sudden load changes the feedwater regulator cannot be held responsible for the swinging water level and cannot be expected to maintain constant level. However, the factors which control the amount of "swell" and "shrink" are controllable, at least in part, by the circuit resistances designed into the unit.

Because water level regulation introduces no problems during steady load operation but constitutes only a desirable safety measure, further discussion will be limited to varying load conditions. Obviously, the forces necessary to accelerate a large body of fluid are greater than those required for a small body of fluid just as the application of power to accelerate a truck is greater than that for a passenger car between the same speed and time limits. Axiomatically, therefore, one requirement for a boiler designed for rapid response to changing load is the existence of the least volume of fluid within the circulating path commensurate with the amount of heat to be absorbed. To some engineers accustomed to dealing with multidrum large volume boilers for varying load this may seem completely contrary to operating experience, but a careful analysis of the rates of response will reveal that the amount of vapor which must accumulate below the water level before circulating velocities can be increased is greater and the accumulation extends over a longer time than when a smaller quantity of fluids is present. Actually, the greater increase in volume is evidenced by a water level change usually greater but spread over more area so that to a casual inspection the amount of "swell" seems less. The comparison of the rate of response is always in favor of the design requiring the lesser amount of fluid to be accelerated.

Closely associated with the volume of fluid is the mass of the pressure parts and the influence of that mass on the rate of response. With each rapid fluctuation in load there is an associated pressure change which in turn automatically causes a temperature change. In generating units with a large mass of pressure parts all of the steel must be heated on rising load (and pressure) and cooled on falling load. The pressure parts thus constitute a mass in which heat must be raised or lowered rapidly and in quantity to maintain desired relationships between pressure and load characteristics. In any case excess mass of water or steel slows the rate of response.

Resistance to flow increases with increased flow and also with increased proportion of vapor in the fluid. The affect of resistance is to increase the forces required for increasing the velocity from that which exists at one load to that which is in equilibrium with the available forces at the higher load. Obviously, the circuit resistances should be minimized in a steam generator designed to operate under swinging load conditions just as the mass of water and steel should be minimized. A freely circulating boiler with rapidly acting heat input control can meet very severe fast load changes with a minimum change in drum pressure and a minimum change in water level. No boiler will operate without some change in pressure and water level under such conditions. Actual-

ly, industrial boilers, observed by the writer, have changed from 50 per cent of normal peak load to 150 per cent within 45 seconds, returning to minimum within the next 45 seconds and repeating this cycle for three or four hours. The water level change was about six inches and the pressure variation from 150 gage to 143 gage. The plant had fast acting combustion control that regulated four spreader stokers. By design, generating units can be made to respond rapidly to fast and repeated load changes without undue disturbance of operating conditions.

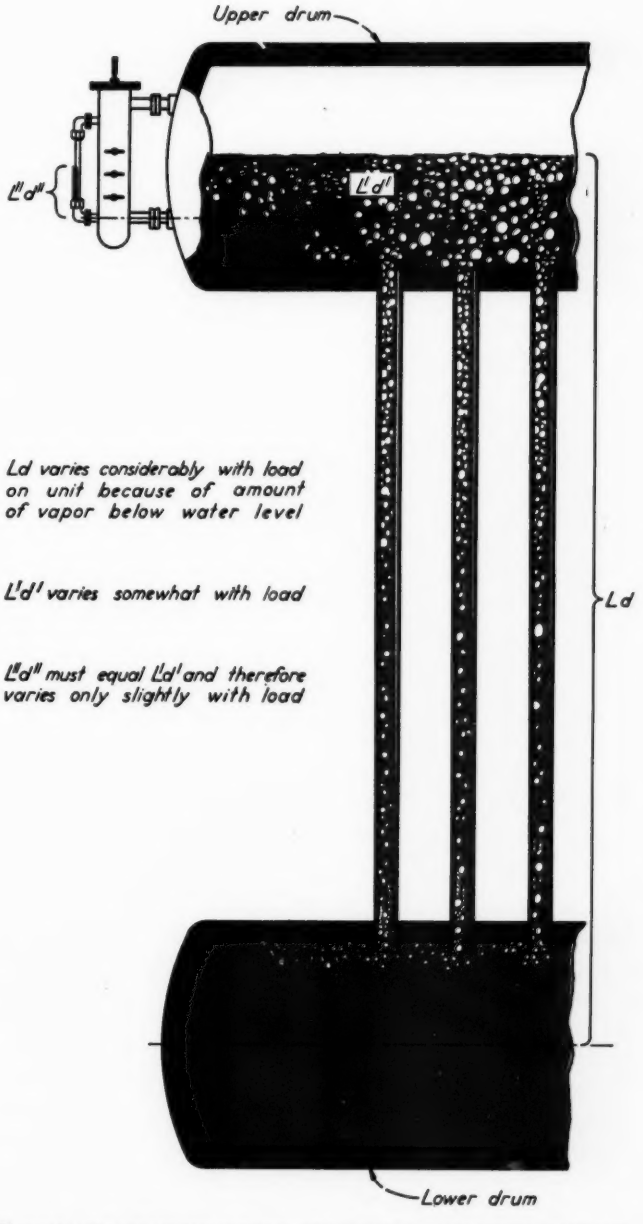
The foregoing design factors have been discussed to indicate certain features of varying load operation beyond the control of the water level regulator. Of course, the bias of the one or more impulses controlling the regulator system must be adjusted to suit the net internal effects beyond the control of the regulator. For instance, the vapor flow element must hold the regulating valve open sufficiently on rising water level due to "swell" on rising load so that some of the "swell" is reduced by the cooler feedwater even though the level element is trying to close the valve. Conversely, on falling load the level sensitive element tries to open the regulator but the low rate of vapor flow holds back the opening. If this were not so the drum might be fed too much water at this time and flood at the time of the succeeding "swell."

In another instance, under laboratory test, a full sized boiler was operated at maximum rating under steady conditions. The rating was set at the maximum capacity of a single feed pump with all valves wide open. For the purposes of the study it was decided not to operate additional pumping equipment. Small variations occurred in heat input through the fuel and it was possible to compensate for these by raising or lowering the feedwater temperature. Thus, in reality, the total heat input was held constant by varying the heat content of the feedwater to compensate for slight variations in fuel supply, and constant water level was maintained.

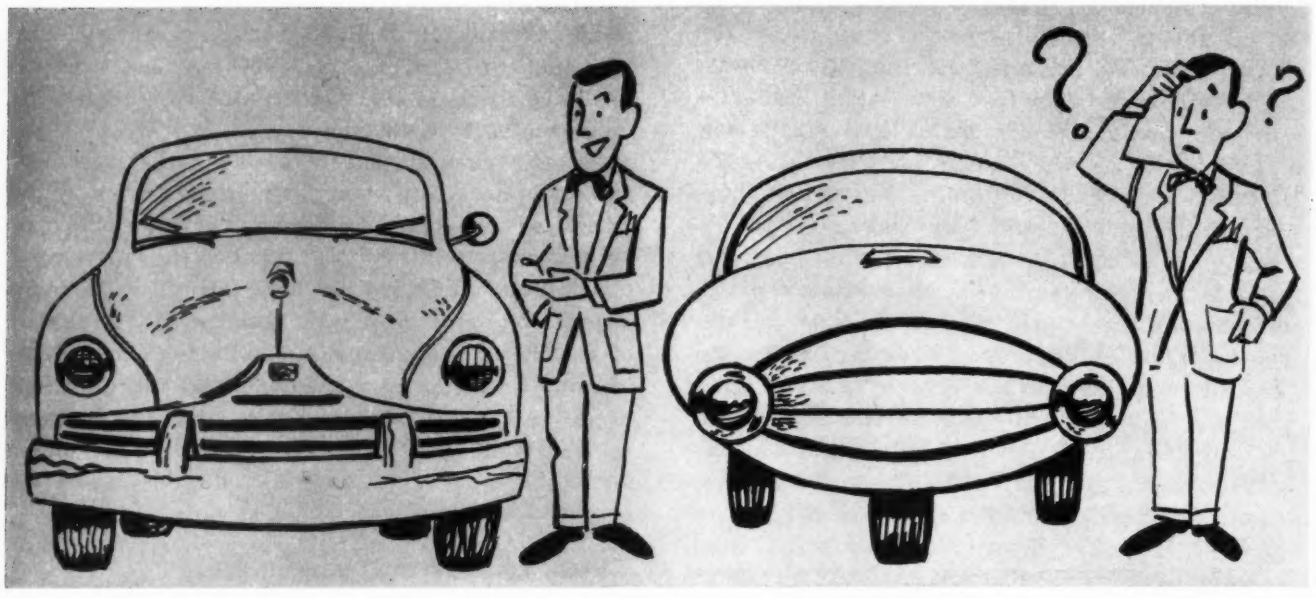
Actually, under steady conditions of heat input and output the water level should be constant. Any cyclic variation in water level under steady heat conditions is an indication of disturbance in related factors. Such circumstances can be interpreted by the trained observer to indicate, for example, an intermittent variation in circulating velocities.

One other factor which appears to amplify the "swell" and "shrink" associated with rapid load changes is the concentration of chemicals in the boiler water. In a preliminary series of observations it has been noted that the disturbances are less at moderate than at high concentrations. It is not known whether the effect is attributable to a single component or to the total concentration of dissolved and suspended matter. The effect is of little significance at normal concentrations but is pronounced at abnormally high concentrations.

Most observations of water level are made for the purpose of assuring the operator that there is sufficient water in the drum to permit safe operation. Frequently a rapid rise in water level has been interpreted to mean that the regulator permitted too much water to enter the drum. Usually, a simple arithmetic computation will reveal that the feed system is not large enough to supply water at the computed rate. Thus, the external regulators cannot be held responsible for the liquid after it is passed through the valve. However, by careful adjustment a good regulator on a well designed boiler can be of considerable assistance in minimizing the effects of rapidly varying loads. Water levels and the usual variations the indications show are much more significant concerning the fluids within the steam generator than the safety phase which was the original conception.



SCHEMATIC DRAWING SHOWS THAT GAGE GLASS LEVEL CANNOT INDICATE CHANGES IN DENSITY OVER HEIGHT OF GENERATOR



CONVENTIONAL MODEL SALES ARE EASILY PREDICTED, BUT A COMPLETELY NEW DESIGN REQUIRES A MARKET STUDY.

Market Studies
Help You Guess Right

By S. A. PECK

Executive Vice President

The Trundle Engineering Co.

Mr. Peck was graduated from Purdue University with a Bachelor of Science Degree in Mechanical Engineering in 1914. He began his industrial and business career with the Diamond Chain and Manufacturing Company, as a Production Manager, Standard Practice Supervisor, and Factory Cost Accountant. His work was interrupted, however, by service with the United States Army from 1916, to the end of World War I. First he saw service on the Mexican Border and then as an artillery captain of the 150th Field Artillery.

When he returned to civilian life, Mr. Peck rejoined Diamond Chain and remained with that firm until 1922. For the next seven years he gathered experience in a variety of jobs with three different companies. He served as Production Engineer, Chief Time Study Engineer, Purchasing Agent, and Office Manager for the Real Silk Hosiery Mills, The Columbus Tool and Handle Company, and the Van Dorn Iron Works.

Mr. Peck joined the staff of The Trundle Engineering Company in 1929. As an engineer, supervisor, and officer of the company, he has worked on and directed many of the company's most successful jobs.

The larger industrial corporations (and some smaller ones) look ahead through well established departments to set up studies, statistical analyses, cash forecasting, long range plans, and through laboratories for research and development work. Too often the smaller companies wait for the trends to become well developed and then climb on the bandwagon. They follow—seldom do they lead.

The National Industrial Board recently completed a study of 151 companies and found that all are aware of the need for planning. But the companies showed a wide divergence of methods and time involved. Few standards exist among these firms, and none was certain how far into the future the plans should look.

It was found that many of the larger companies follow formalized procedures but, in the main, the planning was rather haphazard. However, the Board found that whatever planning was being done, either along strict procedural lines or haphazardly, was helpful.

If even haphazard planning is beneficial, an obvious question is raised. How much more good could have been accomplished had the companies used sound market analyses and had they studied sales promotion methods, sales coverage, and methods of distribution.

Management of many small companies and medium sized firms feel they must be followers of the large industrial corporations, since it is only the giants who

EVEN WITH TOP QUALITY, THE PRICE MUST BE RIGHT.

can make the large expenditures necessary for the multi-phased study of marketing and merchandising.

Small Firms Can Plan

Smaller companies need not resort to playing follow-the-leader. They can explore market potentialities through the use of the many competent management consulting firms who can do the job for them at an expenditure within their means. The benefits to be reaped from such market studies will repay the companies many-fold.

The NIB study showed that more than half of the firms, which do plan, attempt to chart their sales activities. Without proper guidance through adequate studies, such preplanning may go astray or be faulty in terms of the company's market potential.

Periods for which the plans are made vary from a year to a decade. This is usually tempered by the type of business or industry. Large corporations with vast plants and markets do long-range planning, particularly in the field of capital expenditures. The smaller company is involved here also, but not to the extent of companies like Dow Chemical or du Pont or United States Steel.

Business and industry these days are deeply concerned with their future. For many firms this year, the books have shown increased sales volumes and decreased profits. So management ponders over what might happen should the volume decrease through the leveling off of the defense program and the elimination of backlogs. Businesses have been impelled to take a second look at their sales and marketing organizations because of the fears of what the future may hold.

The sales manager of a large appliance manufacturing company was recently quoted in *Business Week*. "We've been badly fouled up around my place for years, but it never mattered. We could sell anything we could make. But now it matters very much, and if we don't do something about it, we'll go to the wall."

The result is that a veritable revolution has been taking place in the sales picture—new techniques, new methods of planning, revamped marketing programs, staff sales planning, and remapped territories. But the base of it all is the market study.

The Market Study

Essentially, three things are determined in any market study: (1) the acceptance of the product, (2) the sales method, and (3) the market (size and share) for the product. This seeming simplicity can

ONE FIRM FOUND SALES DROPPING BECAUSE THE TRADE NAME WAS WRONG. IT SHOULD HAVE STRESSED ECONOMY.

become highly complex when the numerous qualifying and modifying factors are added.

Here is a hypothetical case.

Universal Motors Corporation knows that its atomic V Eight automobile is an accepted product because of its sales and its share of the automobile market. But Universal would like to know how many Atomics it can sell next year and the following year. Here we have a rather simple case of studying the past history of the market and the past history of the car and making the projection by studying the population group which buys the Atomic.

But, suppose Atomic will now be built with the engine in the rear. Will it be accepted that way by the buying public? If so, will it continue to command the same share of the market that it did? What sales methods will be needed to sell it with a rear engine?

Now add another ramification. The rear-engined Atomic will be made with three wheels, a single wheel in front. Again we face the same problems, by now somewhat complicated. Will a three-wheeled car be accepted at all? And still another step—what if it were to be made in a small sports model similar to the English Austin or the German Volkswagon?

Perhaps the study will report huge acceptance and a tremendous market for the midget, rear-engined, three-wheeled Atomic. There then arises the added problem as to whether Atomic has the plant facilities to meet the expected demand for the new car. What happens if the study shows no acceptance of either a rear-engined, or a three-wheeled, or a midget sports car? The answer is obvious. Universal will save itself countless headaches and heartaches and money by scrapping all plans before production is ever started on the very first car.

Finding the Market

Let's examine some of the market studies in the case books of the Trundle engineers. Through them we can see in how many directions business must look through the telescope of the market study.

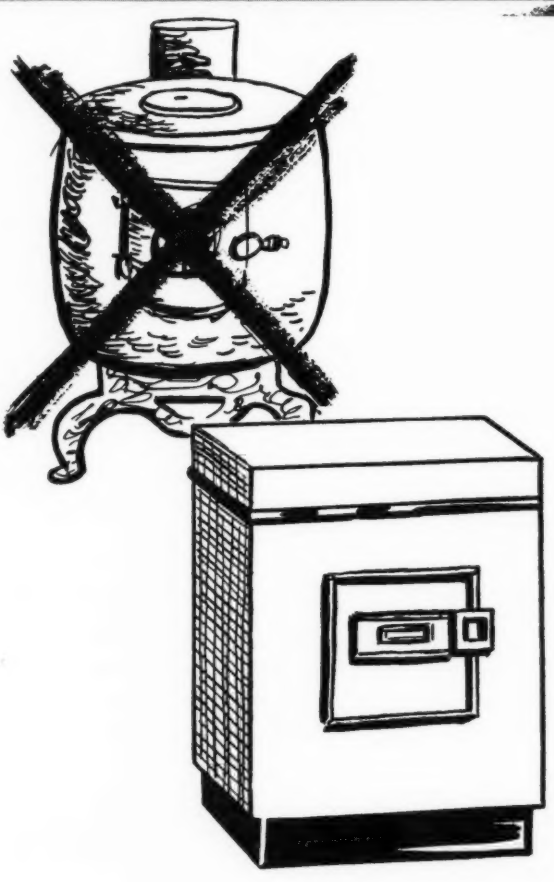
The first case is that of a rubber products manufacturing company with unused facilities. This company sought to increase its volume by utilizing those facilities.

The company was making molded rubber products, and the officials felt that the firm was at a standstill and not progressing. Anxious to operate the unused facilities, the company was at a loss as to where to begin. They decided on the market study.

A $33 million market was found by the Trundle engineers right in the company's own back yard. All the firm had to do to participate in this market was to make some of the products that this market called for instead of limiting its production to the same patterns it had been producing over the course of the years.

The results? In one year profits were doubled.

OUT OF DATE DESIGN CAUSED A DROP IN SALES. CUSTOMERS DEMANDED MODERN APPEARANCE.



In the second case a company developed a completely new product. This item would be in competition with all other materials, which are used for packing, upholstering, and cushioning. It had a basic cost handicap, and the company had to learn whether or not to manufacture this product commercially.

The market for the new product was studied thoroughly in the field and in the laboratories of potential users. The results of the study showed that the furniture and packing materials industries would not accept the product as a substitute for those currently being used unless the price was lowered.

Production and material costs were refigured, and the company found that any lowering of price would make the new product unprofitable.

The results? This company saved a minimum of $150,000, the estimated cost of the initial effort to manufacture the product commercially.

Poor Trade Name

A third company, a manufacturer of home heating units, had been enjoying good sales for a number of years. Then sales dropped sharply while the market for the product remained high. Why?

During the booming war years when the company was manufacturing ordnance materiel, it had lost

much of its former market. In the post-war years when it sought to regain its position, it found that it was encountering buyers' resistance.

In conjunction with the market study, the sales organization was overhauled. It was found that the bulk of the sales resistance hung on the trade-name applied to the product. Times had changed. In previous years the name did not hinder sales. After the war, the name was not conducive to sales. So a new name was found, which implied that the unit was an economical heater.

What's in a name? To this manufacturer the answer was profits.

Other Studies

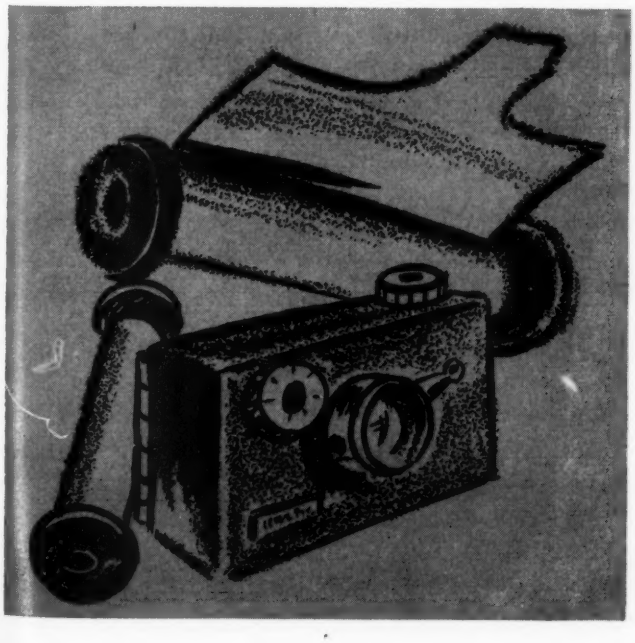
A foreign company was manufacturing a non-ferrous tubing which, on an import basis, could not compete with American made products. An American company was licensed for production of this alloy tubing.

To manufacture it, the American company found it would need additional plant facilities. The problem, which the company handed the Trundle engineers, was two-fold. Would there be a market here for the product, and if so, would it be economical to build additional facilities? Negative results were obtained in both instances. An unprofitable plant was never built and potential marketing costs were never expended.

Then there is the case history of a company, which sought greater diversification and contemplated the addition of a plastic product to its line. The company selected a product and then asked for the market study.

A well-established, highly competitive field already existed for the product. To gain a share of the market, the company would have to undersell the competition. The item would be unprofitable.

THE COMPANY DESIGNED AN EXCELLENT CAMERA AND THEN FOUND TOO LATE THAT THERE WAS NO FILM TO FIT IT.



The results? Abandonment of plans, which if carried out, would have been very costly.

A company investigating the bottling machine field had a new attachment that gave the bottling operation a quick cut-off of flow for exact measurement. The attachment was designed primarily for the milk industry which, at the time, used bottles almost exclusively. The investigation revealed the coming of the paper cartons.

The results? This company decided not to market its new attachment but to go instead into the carton business, which proved a profitable field.

Long-Range Projection

Let's look at some companies that wanted long-range projections of their sales plans. One wanted to know how many washers, dryers, and ironers it could sell in the next ten years. Another was anxious to survey the home heating field and estimate its sales. The third, a newspaper, wanted a new plant but first asked if its future circulation and advertising linage would justify the expansion.

For the appliance manufacturing firm, a national survey was made. The conclusions were that with a sound marketing program the company could sell over one-half million units. This was based on the projection of the population growth, the establishment of new families in that span of years, the shift from the conventional to the automatic washers, the history of the appliance, the company's past position in the market, and the company's probable position in the market as a result of the merchandising and sales programs. A host of lesser but important factors were also studied.

Expansion of the foundry, the manufacturing facilities, the engineering and research departments, and the offices followed.

The results? The company is producing and selling slightly in excess of the projected figures.

Loss of sales spurred a home heating company to call for a market study. This survey revealed that the product was losing public acceptance because the manufacturer failed to keep abreast of technological advances. This particular company envisioned a business boom shortly after the war because of the backlog, which had been built up in addition to the normal replacement business.

After the initial warnings were shrugged off, the company began to realize that the replacement business did not develop as rapidly as it should have. Much of the backlog began to melt away as the public shifted from old style cast iron units to more modern steel units.

This trend was corroborated by the president of another company who wrote that he was deeply concerned over the decrease in volume and the failure of the replacement business to materialize. He

asked if the same trend was noticed in the mid-west. He, too, had neglected to follow the technological advances. Both companies were victims of failure to heed the indications revealed in a projection made for a five-year period. Both thought that the post-war housing boom would keep their plants operating at peak capacity.

The results? Both companies redesigned their lines and now are regaining their former positions.

The newspaper needed definite information concerning its future. If the area, which it served, was to remain fixed in population size and industrial development, it could continue to operate comfortably without altering its quarters. Population's growth and continued industrial development would result in greater circulation and increased advertising linage. These circumstances would necessitate larger and faster press runs, additional typesetting equipment, improved newsprint handling, and greater loading dock facilities.

Entailed in the survey was a complete study of the history of the area, the history of the paper, the population and industrial growth of the market, the opening of new rail, highway, and airline links, and the effects this growth would have on the retailing and wholesaling of goods and services.

At the completion of the study, a very definite and fairly rapid growth was indicated in the coming ten-year period. This was translated into circulation and advertising linage figures. Similar growth patterns were traced with comparable newspapers' histories in comparable cities where the population, industrial, and transportation growth was equally marked.

The results? The newspaper plant at present is undergoing extensive expansion with new equipment being added to meet the requirements of the future years. Increases well in excess of the forecast have already been noted since the initiation of the study, and again since the actual start of the construction work.

Inadequate Studies

One company overlooked the simple two syllable word "service" in making a market study for its client. The oversight sent three years of hard work and several hundred thousands of dollars down the drain. The executive vice president of the nationally known company in a recent issue of a marketing publication told the story.

This company for many years maintained a product research and development division. Since this company constantly sought more and more diversification, the division was charged with developing new products and exploring existing products, which could be retailed through the same outlets that sold the company's other products.

In time the division came up with the thought of a camera. But this camera would be different. It would be small. It would have a minimum of gadgets and be designed to satisfy completely the amateur.

Basing their thinking on a survey that showed only 2.3 rolls of film per camera per year being used, the company reasoned that most cameras are too bulky to be carried constantly. Hence, the camera is usually at home when the owner wants it.

The new development, then, would be a camera that would not exceed in bulk a king-size package of cigarettes and could be carried in the vest pocket. The film magazine was to be designed so that it could be taken from the camera to extract the exposed film, yet permit the unexposed film to be returned.

The camera was developed. It did what it was supposed to do—take good quality pictures with a minimum of controls and yet be flexible through the built-in coordination of the variable settings.

What remained was the field test. Here a full blown promotion program was designed. A pilot run of 100 cameras was made. One city was selected, stores for retailing chosen, sales clerks trained, instruction booklets prepared, and photo-finishing arranged. World wide promotions were to follow.

Picture quality of the pilot run cameras was good, and the company felt that it had really come up with something. Then the things that looked so rosy turned dark.

"Service," the forgotten word, rose to haunt them.

To make the camera so easily portable and workable, an odd size film had to be used. Film just wasn't made in that size. The company realized too late that it was of little use to have a camera for which film was not readily available.

Said the executive vice president, "There had to be international availability, and for the product to enjoy success, that had to be accomplished broadly at the time the product was introduced. The marketing could not be successfully handled in a creeping manner from one city to another or one country to another. The speed of photo service, as well as availability, became all important." At a management meeting all plans for the camera came to a halt. Time and money were gone.

The moral? If a product requires service in any degree, service factors become as much a part of the study as is the product itself.

Knowledge Is Needed

Through the prevalence of sound management principles and the application of the many scientific management tools available, one might think it impossible for a business to be unsuccessful. Yet businesses do fail.

What does it avail to have sound production and inventory control and all of the host of other tools, if we do not know what we should make, where we can sell it, how much of it can be sold, and at what price?

If you don't know, find the direction through to market study, or you will be traveling down that lonesome road where the signpost points to failure.

Dr. Palyi's Page

Each month on these pages Dr. Melchior Payli, Consulting Economist, answers readers' questions on economics and finance. Address mail to: Editor, CONSULTING ENGINEER St. Joseph, Michigan

Question: What effects have the expiration of price and wage controls had on industry?

Answer: Practically none. As a matter of fact they were not effective even before they were abolished. In a few industries they had the favorable effect of eliminating governmental interference and letting prices adjust themselves to a reasonable supply-demand level. A few prices had a "delayed" rise, which is as it should be.

Question: There are indications of an increased rate of armament production. What is behind this increase?

Answer: Several factors. One is that a substantial number of armament plants, which were started a year or two ago, have been completed, and the goods are flowing in huge quantities from the assembly lines. Another factor is the gradual unsnarling of red tape which has enveloped armament production. Now, if we eliminate one "bug" after another (such as in jet and tank production), industries receive orders and get into production. There still remain very important problems to be decided upon on both the strategic and on the technological level. As overall decisions are made, such as whether to produce more battleships or more planes, new orders will be forthcoming.

I expect rising rather than declining armament production, notwithstanding a truce in Korea which would not alter the picture in any basic fashion.

Question: Would you expect this increased armament production rate to cut into civilian goods production?

Answer: It would in the sense that it would limit the possibility of expanding civilian goods production, but not in the sense of seriously limiting or reducing the existing volume. As a matter of fact, the problem this year and next will be whether the capacity available for civilian production will be fully utilized. Industries may be scrambling for government orders to keep their plants in full operation.

Question: How is the movement toward industry-provided pensions for employees affecting our industrial economy?

Answer: This is, of course, a very broad issue and industry-provided pensions cannot be considered alone. They have to be considered in conjunction with social security and similar developments. By and large, we are on the way to a system of pensions which would absorb the productive capacity of the country, if it were permitted to proceed much further. The burden threatens to become unbearable (short of a runaway inflation that would wipe out the pensions). Moreover, the industrial pension system has a tendency to reduce the mobility of labor, which is disadvantageous in the long run to labor itself, to industry, and to the national economy. Europe suffers, among many other ailments, from too many pensions and too little labor mobility.

Question: Would expanded government-operated old age insurance, instead of industry-provided pensions, solve the problem of labor immobility?

Answer: From the point of view of labor mobility, it may be more advantageous to rely on a general social security system rather than on industry-wide or individual company systems of pension. But the advantage is not very great, for there are terrific drawbacks involved in the old age security system compared with industrial pensions. For example, there is no advantage in being in one industry rather than in another, in being with one plant rather than with another plant. There is no way for the better enterprise, within the framework of pensions, to attract better workers by giving them more than its competitor does. And the social security system has a tendency to reduce labor's inclination to look for the best job or put in the best effort. Therefore, the ultimate result will be that the distribution of labor may be even less economical under the social security system than under the industrial pension system. Also, social security, being a political institution, is likely

to expand without limit, creating grave inflationary and self-defeating hazards.

Question: For many years we have had the problem of privately owned as opposed to government owned utilities and other natural monopolies. Is there any answer to this?

Answer: We all agree that where natural monopoly prevails, something has to be done about it. In principle, it may not make much difference whether the privately owned natural monopoly is controlled by the government, as the F.P.C. and the public service commissions control the power companies, or whether the government takes over altogether. If the monopoly is the kind of business that requires risk capital, if it involves considerable technological progress, I would say that private ownership is preferable. But in general, I would argue that the best solution for local natural monopolies, such as water works and similar public utilities, is the old German system of combined ownership by the municipality and private enterprise, on a fifty-fifty basis. In Germany, the burgomeister is the chairman of the board, and the entrepreneur is the president of the company; between them they regulate prices and serve the public. Of course there is the danger of local politics entering, but every hazard cannot be eliminated.

Question: Could this system sensibly be adapted to state, regional or, national natural monopolies?

Answer: Most certainly. The problems become a bit more complicated, but suppose there is a mineral with a few producers, or a single one, having a practical monopoly. There is no reason why that business couldn't be shared by a state or by the national government—or regulated on a broad level.

Question: What is the most sensible way to alleviate the scarcity of engineers and other technical personnel in this country?

Answer: The problem has two levels. One is the absolute shortage, that is the fact that there are not enough engineers to go around. That cannot be solved by redistributing them, but only by increasing their number through education on the one hand, and on the other hand, by reducing the demand for them. If we did not have an economy thoroughly watered by inflated bank deposits and currency, we wouldn't have so much demand for mechanical and electrical equipment and not so much need for engineers to make and service those gadgets.

Secondly, there is a question of distributing engineers. There are too many engineers in sales functions as compared to the number in true technical functions. Now, we do not want to introduce the Russian system of allocating people as slaves. We must leave the choice of occupation to the individual on a free market. On the free market, the engineer has the same tendency as other human beings—to go where he gets the best pay. Presumably they don't get enough pay in the technical functions. Raise their pay and you get them.

Question: What, in your opinion, should be done to revise the corporate tax structure?

Answer: The most important single problem is the excess profits tax. That is the silliest, most vicious tax we have on the statute book. That tax should be abolished and, if the revenue is absolutely needed, replaced by a higher rate of the regular corporate tax. But I don't believe the change is likely to be made under present circumstances because any start with a tax reform would bring up the question of tax reduction, which is taboo for the administration.

Question: Is it logical for income taxes to be formulated on a progressive basis?

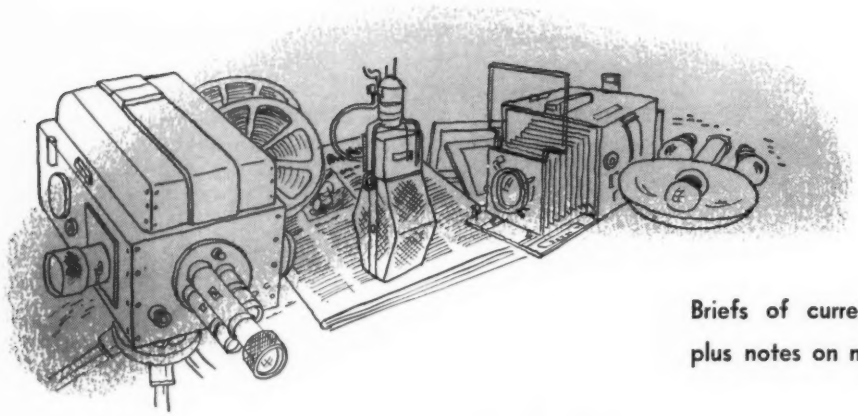
Answer: I think progressivity is essential for any direct tax because otherwise great injustices would be inflicted. Some progression in the tax rate is necessary. But, of course, to carry the progression so far as we and most countries now do, namely to take 90 and more per cent of the income in the highest bracket, is plain foolish because of the economic and social consequences of such a confiscatory taxation.

Question: If there were no currency restrictions abroad, would there be any world dollar shortage?

Answer: The elimination of currency restrictions in Europe and elsewhere would be a tremendous contribution to reducing the dollar shortage. Without currency restrictions, the respective countries would be forced to reduce their expenditures on things they don't really need. It would also give them an incentive to export more. But the problem is not that simple. It is useless to abolish currency restrictions or to introduce the gold standard if simultaneously the budgets are not balanced. Pretty soon a run will start on the gold and dollar reserves of the respective countries since unbalanced budgets in those countries where people have little confidence in the currency would mean, in the eyes of people, that the freedom of buying foreign exchange would not last. In other words, it is no use to eliminate the currency restrictions unless domestic reforms are taken which stop the inflationary tendency.

Question: What, specifically, do you mean by "domestic reforms"?

Answer: In the first place, balancing the budgets, and balancing genuinely, not just balancing above the line and then have a deficit below the line for the purpose of "investment", as in the British budget. To balance the budget they must reduce social expenditures. That involves reforms of a manifold nature. How far they must go differs in different countries depending on the individual situation. But in all cases, countries suffering from a dollar shortage must undertake a very substantial reform of their spending policies—and of their taxing policies, too.



NEWS

Briefs of current interest to the consulting profession plus notes on new equipment in the field of engineering

Unusual Construction Technique Used for Wharf at Kitimat

Ocean steamers bringing alumina from Jamaica to the Aluminum Company of Canada's new aluminum smelter at Kitimat, B. C., will dock at a 750 ft long wharf now under construction. Design of the wharf is being handled by Frederic R. Harris, Inc.

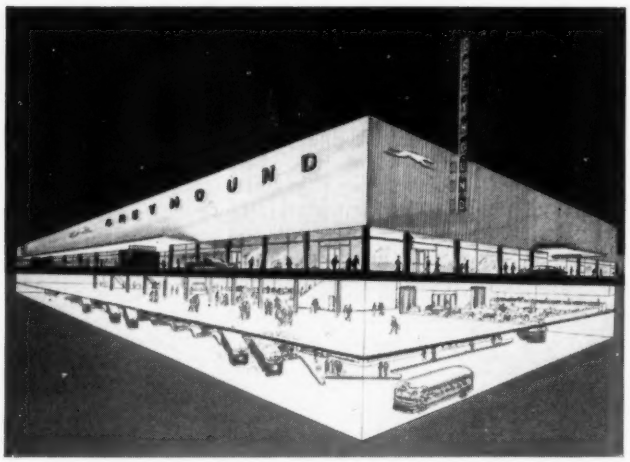
Cellular concrete caissons are being employed in construction of the wharf. Similar construction now exists in Montreal Harbor and many other foreign ports. According to the consulting engineers, however, the method being used to construct the caissons is unique.

A basin, shown in the above illustration, is being dredged out of the beach. Its bottom is a few feet below low tide. Inside the basin, which is totally enclosed with an earth dam, the concrete boxes will be built on their sides with the least dimension as the vertical. Dimensions after being set in final position are 65 ft high, 45 ft wide, and 250 ft long.

Three of these caissons, which comprise the full 750 ft length of the wharf will be built simultaneously in one basin. Upon completion, the surrounding dike will be broken and the basin flooded at high tide. The boxes will be floated out, one at a time, to deeper water. They will not touch bottom at low tide. After they are afloat, the boxes will be careened through 90 deg by adding ballast at one end to float them in normal upright position. They will then be towed to the wharf site where additional ballast will be added to set them on the bottom in final position.

Completion of the wharf will consist of filling the caissons with gravel and stone, and placing fill behind them. A warehouse and crane will be built on the wharf, and railroad tracks will be constructed to handle loading and unloading of equipment.

The decision to build the concrete boxes on their sides and put them through a careening operation was based on economic considerations. In addition to permitting a shallow basin, the draft of the boxes afloat in the flat position is less than if in the final upright position.



Chicago's New Bus Terminal Features Private Tunnel Approaches

The first multi-million dollar building to be completed in Chicago's Loop in nearly 20 years was opened for business in March. This structure, the new Greyhound Terminal, represents a total investment of $10 million and almost four years of construction.

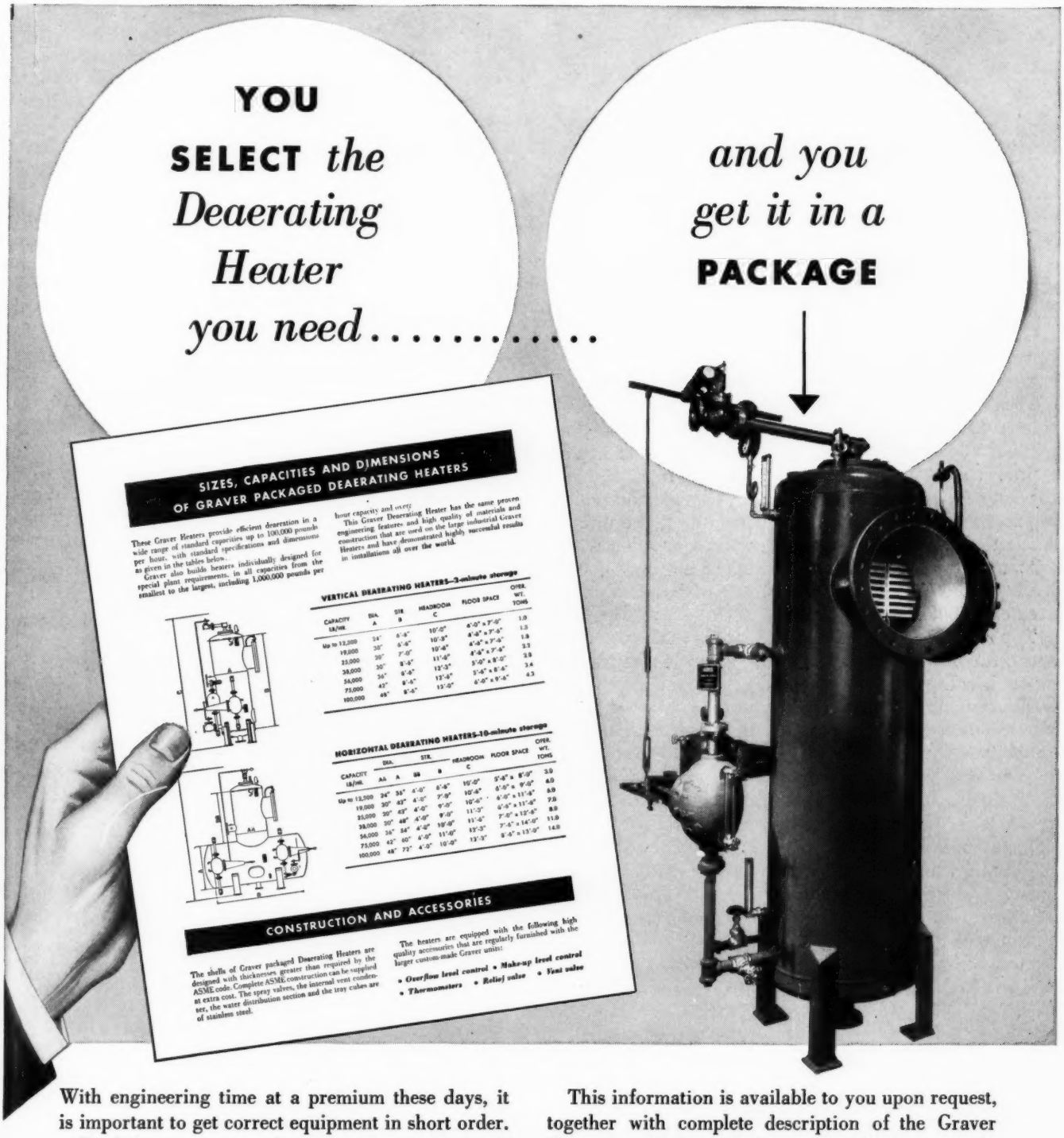
It occupies an area of 66,000 ft, and is a five level structure—three above and two below street level.

Its loading concourse, located in the second lower level, makes the terminal unusual since it keeps buses off Loop thoroughfares. The buses enter the concourse through a 225 ft long private two-lane tunnel. The tunnel is 13 ft high, and has two separate and divided 15 ft wide lanes. An electric heating system imbedded in the concrete melts all ice and snow on the approaches. Enroute to the terminal, buses from

(Continued on page 54)

YOU SELECT *the Deaerating Heater you need.....*

and you get it in a **PACKAGE**



With engineering time at a premium these days, it is important to get correct equipment in short order.

To help you get a *deaerating heater* that will exactly meet your needs, Graver has developed charts and data sheets that give complete engineering, selection and dimensional information for a wide range of heater capacities.

This information is available to you upon request, together with complete description of the Graver Deaerating Heaters which are furnished as a package . . . with all internal parts, controls, valves and instruments you need for the installation. Your request for this information will not involve the slightest obligation on your part.

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GRAVER ***Deaerating Heaters***

Chicago's New Bus Terminal

—*Starts on page 52*

all directions will use the lower level of Wacker Drive, one of the least congested streets.

As buses enter the concourse from the tunnel, they are directed to the proper loading zone by a flashing number system. Over-all size of the bus concourse is 160 x 380 ft, allowing ample room for maneuvering and passing. The ventilation system for the open section of the concourse, where buses will be parked, has a capacity of 180,000 cfm.

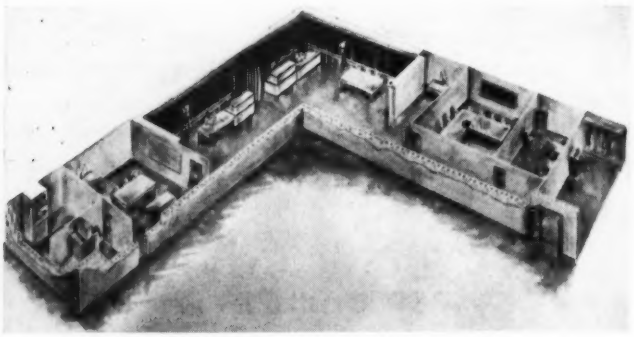
Checked baggage is handled in the bus loading concourse by conveyors built under the floor. Moving ramps then bring it to the baggage room.

Three moving stairways run from the bus concourse to the waiting room above. Center of the waiting room is two stories in height. Three more stainless steel electric stairways, with a combined capacity of 5000 persons per hour, service the waiting room to the street level. Surrounding the upper section of the waiting room are wide arcades with entrances to three streets. Facing these arcades, and having street frontage, are 13 stores with a combined area of 39,600 sq ft.

Top two levels of the building provide parking space for 500 automobiles, with ramps leading from street level.

The entire waiting room area, the arcades, and all stores are air conditioned with a plant of 610 tons capacity. Equipment for ventilation and air conditioning has been installed in space provided on the roof. Entire frontage of the building, above the store level, is faced with stainless steel.

Skidmore, Owings and Merrill were the architects for the new terminal. Erle F. Webster was the supervising architect for Greyhound. John W. Harris, Associates, Inc. were the general contractors. The terminal will be operated as a subsidiary of the Greyhound Corp., the holding and management company of the entire Greyhound system.



Utilities Combine to Finance A-C Network Analyzer

Contracts have been signed with seven power companies in Pennsylvania, New Jersey, and Delaware for the installation of an a-c network calculator in the industrial research laboratories of The Franklin Institute in Philadelphia. The companies—Atlantic City Electric Co., Delaware Power and Light Co., Jersey Central Power and Light Co., Metropolitan Edison Co., New Jersey Power and Light Co., Pennsylvania Electric Co., and Philadelphia Electric Co.—will use this modern computing device to help their engineers solve the many complex problems involved in maintaining and expanding power systems.

Westinghouse Electric Corp. will build and install the $400,000 calculator in a specially-fitted room atop The Franklin Institute. In the summer of 1954, when installation and tests are complete, the calculator will be put to work. The power companies have agreed that if they do not require the full time allotted to them, they will place the device at the disposal of other utilities.

The calculator will incorporate 580 circuits, representing generators, transmission lines, transformers, and loads. These circuits will be in two separate units. Each can operate separately, or both units can operate together if the problem demands. An operator at either one of the two instrument control desks will be able to make measurements throughout the entire calculator. The calculator, conference rooms, office storage space, power supply and air-conditioning machinery will occupy 2500 sq ft.

Portable Microfilming Equipment Available for Offices

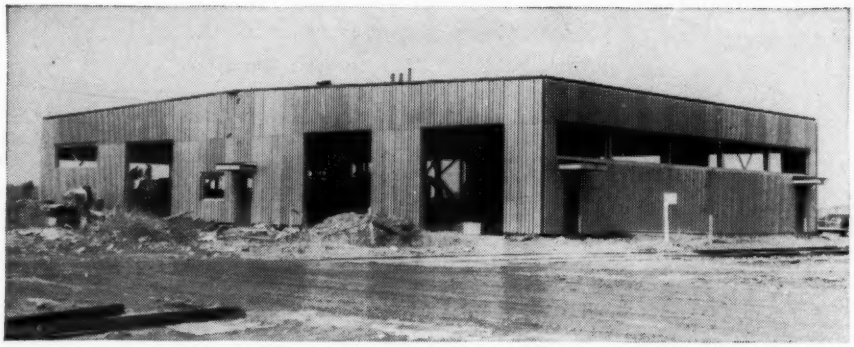
Portable microfilming equipment, said to be fast, compact, and inexpensive enough for use in daily office routines, has been developed by Diebold, Inc. Recently this company announced a portable microfilm camera which can be set on a desk top or table and fed any size paper up to 11 in. in width and ranging from tissue to cardboard thickness. The camera does not require an experienced operator, and is said to require virtually no servicing.

As a companion unit to the camera, Diebold is now manufacturing a portable reader for 16 mm film. The

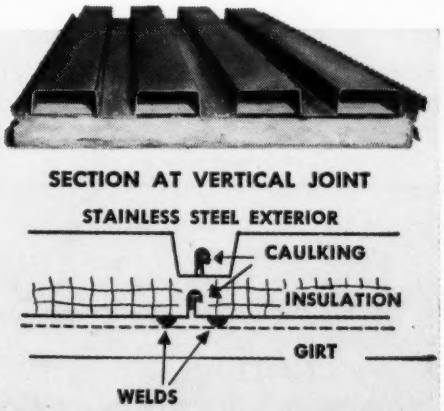
(Continued on page 56)

Insulated panels of U·S·S 17 (Type 430) Stainless Steel mean fast, low-cost construction at Fairless Works

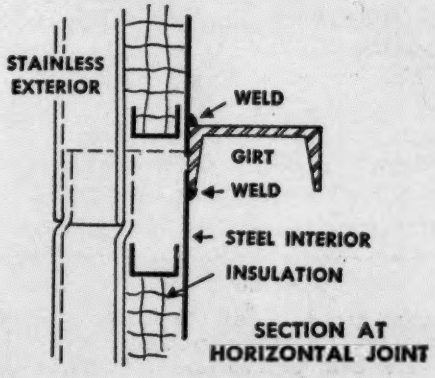
4005 sq. ft. of panels installed by crew of 4 in 8 working days



WORKING UNDER ADVERSE WEATHER CONDITIONS, a crew of four installed 4005 square feet of insulated Stainless Steel panels on this building in less than eight working days. Panels were manufactured by H. H. Robertson Co., Pittsburgh, Pa.; installed by R. A. Steelman Co., Trenton, N. J.; engineers, Walter Kidde Constructors, Inc., New York.



THESE DETAILS of panel cross sections show methods of making horizontal joint (below) and vertical joint (above). Such methods of joining, combined with the low "U" factor designed into these panels, produce an exceptionally well insulated building.



CONSTRUCTION with insulated building panels of U·S·S 17 (Type 430) Stainless Steel is gaining considerable momentum in the field of industrial building—such as power plants, factory office buildings, warehouses, etc. Architects and owners alike have been quick to recognize the advantages of light panel weight, long building life, minimum maintenance, low labor costs and fast erection in any type of weather.

The building shown here is a Stainless-paneled fire station at the new Fairless Works of United States Steel Corporation at Morrisville, Pa. The 66′ x 100′ structure contains 4005 square feet of insulated panels of 20 gage U·S·S 17 Stainless Steel.

A crew of four men erected the panels under adverse weather conditions in less than eight working days. The prefabricated sandwich panels, consisting of U·S·S 17 (Type 430) Stainless Steel exterior, 1½″ of insulation and a coated steel sheet interior, were attached to the structural steel framework by spot welding, a fast and strong method of installation. U·S·S 17 (Type 430) is readily available without CMP tickets.

Note the cross-sectional sketches of the horizontal and vertical joints. As indicated in the sketches, caulking is applied to the vertical joints prior to erection. This provides an excellent vapor seal and is therefore instrumental in reducing the over-all "U" factor. The cross section of the vertical joint illustrates how the lower panel is counter sunk to gain a tight flush joint at the lap.

A new book containing the latest information on construction with panels of U·S·S 17 Stainless Steel is now being distributed. For your copy, use the coupon.

United States Steel Corporation
525 William Penn Place, Room 2811S
Pittsburgh 30, Pa.

Please send me your new booklet on U·S·S 17 Stainless Steel for industrial buildings.

Name.....Title.....

Address.....

City.....State.....

United States Steel produces only the Stainless Steel sheet and strip from which panels of this type are made; the panels themselves are fabricated by a number of our customers.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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U·S·S STAINLESS STEEL

USS

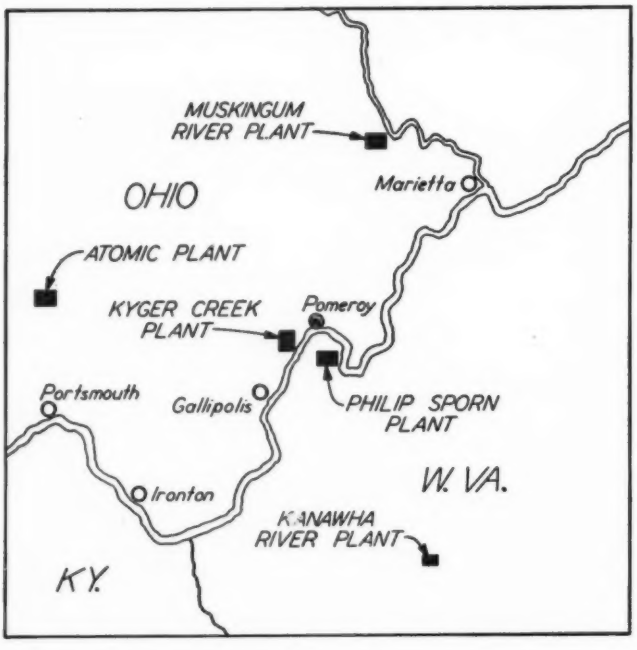
SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

Portable Microfilming for Offices

—*Starts on page 54*

photograph shows the reader unit, known as Flofilm, in operation. It is manually-operated, having a fixed magnification ratio of 24 to 1. Light source is a standard 100 watt bulb, and the image can be rotated 360 deg for legibility in any position. Readable screen size is 11½ x 11½ in.



Ohio River Valley Comes to Life

The calm and serene Ohio River Valley, which for many years has taken life in stride, suddenly has sprung to life. Industries have been seeking plant sites near the banks of the mighty Ohio, coal operators have been given an impetus by the location of many new power plants in the immediate vicinity, and the area in general is experiencing a brand new industrial and power revolution.

To illustrate the changing power situation in this area, if a circle with a radius of 50 miles were drawn around the town of Pomeroy, four of the country's most modern steam-electric generating stations would be within that circle.

Now in operation is the Philip Sporn Plant, owned jointly by Ohio Power Co. and the Appalachian Electric Power Co., and now under construction are three other generating giants. Ohio Power is building a 400,000 kw generating station known as Muskingum River Plant, and Appalachian is erecting a twin plant, the Kanawha River Plant at Glasgow, W. Va. In addition, Ohio Valley Electric Corp. has started construction on the 1 million kw Kyger Creek Plant, only eight miles from Pomeroy.

When all work is completed on the three new plants, they will, together with Sporn Plant, have a combined generating capacity of 2.4 million kw. Another factor that makes the Pomeroy area outstanding in an electrical way is the new 330,000 v transmission line which Ohio Power is building between Sporn and Muskingum plants.

Also within that circle is the $1.2 billion atomic energy plant being built in Pike County.

Construction Progresses on Nation's Largest Atomic Plant

Since the Atomic Energy Commission awarded the contract for operation of its largest gaseous diffusion plant, now under construction in Pike County, O., the most frequent question has been, "Why did Goodyear Tire and Rubber Co. want the job?" The answer, as given by A. J. Gracia, assistant manager of research development for Goodyear, parallels the thinking of many of today's modern industries.

Mr. Gracia pointed out the role which rubber plays in our modern transportation systems, industries, construction, and energy utilization.

"We at Goodyear," Gracia said, "choose to believe that in a peaceful world we can look forward to the production of electrical energy from atomic energy—that as costs are reduced through reactor developments we can anticipate the construction of stationary nuclear power plants.

"As an organization whose basic products tie in so closely with energy utilization, we want to be in the vanguard of such a movement. We want to know what design criteria may be established for our products—what changing applications are developing—what difficult requirements may have to be met.

"Not the least of the considerations," he asserted, "was the simple, straightforward fact that it does an organization good to be challenged—to learn to shift its weight—to be jolted out of any comfortable 'ruts'."

Construction of the new $1.2 billion atomic plant is proceeding on schedule. Recent announcements include a subcontract estimated at $100 million for electrical work, awarded to Reynolds Electric Co., Inc., Albuquerque, N. M., and Newberry Electrical Corp., Los Angeles. The award to the two firms, which have combined in a joint venture, was announced by Peter Kiewit Sons' Co., the general construction contractor. The two firms will install power wiring, control and instrumentation materials, communications and lighting systems, and will test installed equipment.

Earlier this year, Allis-Chalmers Manufacturing Co. reported an order from the AEC for six 100,000 kva, 3-phase, 330,000/13,800 v transformers, and one 150,000 kva, 3-phase 330,000/13,800 v autotransformer. Total value of the order is over $3.5 million.

At the peak of construction, approximately 30,000 workers are expected to be required. Average construction employment will be approximately 17,000.

Contracts to supply all electrical power were signed last October (CE—Dec. '52, p 56). They call for 1.8 million kw to be supplied by the Ohio Valley Electric Corp., a company formed by 15 privately-owned utilities.

(Continued on page 58)

FIRST *complete* packaged boiler

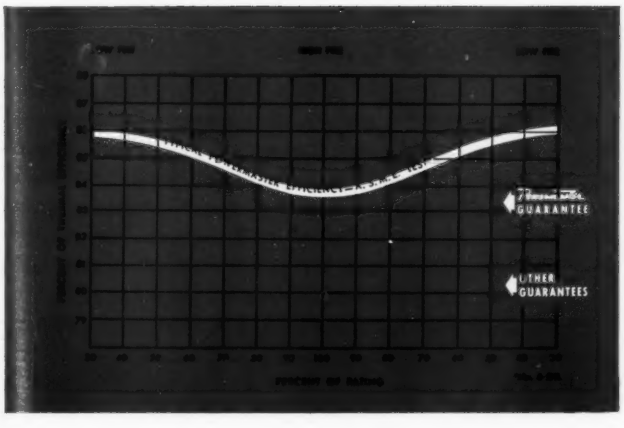
FIRST full modulating cam control

FIRST *Voriflow* air-atomizing burner

FIRST immediate change-over—oil or gas

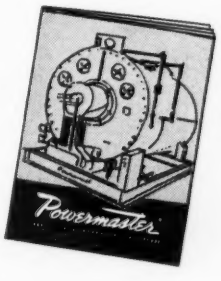
NOW—*Powermaster*® is FIRST to guarantee 83% minimum efficiency

The "pay-off" on a boiler is its operating efficiency . . . and *only Powermaster guarantees a minimum of 83%* with No. 6 oil!



Take a look at the typical efficiency curve of *Powermaster* shown here . . . then compare A.S.M.E. tests with those of any other boiler. At less than full load (which is normal in field operation) notice that *Powermaster* efficiency actually *increases.*

There's a reason for such efficiency. The *Powermaster* is the development of 68 years' experience in boiler manufacture. Continuing research and progressive engineering have resulted in *Powermaster* users being the first to benefit from major improvements in packaged boiler design.



Point-by-point, *Powermaster* welcomes comparison. Before deciding on a new boiler for your plant, be sure to get the facts on the newest *Powermaster* with *Voriflow* combustion. Just drop us a line and we'll be glad to send you our new catalog.

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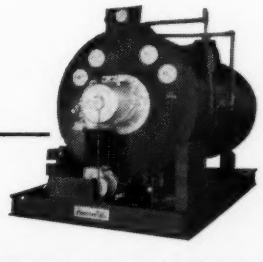
PACKAGED AUTOMATIC BOILERS

In sizes to 500 HP; pressures to 250 psi.



ORR & SEMBOWER, INC. • *Established 1885* • 800 MORGANTOWN ROAD, READING, PENNA.

Nation's Largest Atomic Plant

—*Starts on page 56*

Giffels & Vallet, Inc., Detroit, is the prime contractor for the consulting engineering work on all process plants, and Union Carbide and Carbon Corp. is handling process design.

Consulting work on the steam plant is being handled by Burns & McDonnell, Kansas City, Mo., while design work on technical, cleaning, and maintenance buildings is being done by Smith, Hinchman & Grylls, Inc., Detroit. General purpose structures are being planned by Holabird and Root and Burgee, Chicago. Engineering work on the feed plant is being handled by Singmaster & Breyer, New York.

Sargent & Lundy, Chicago, is designing the high voltage substations and distribution system. Water and sewage treatment plants are being handled by Alvord, Burdick & Howson, Chicago.

To administer the architect-engineer contracts, engineers under Oak Ridge management correlate, coordinate, and inspect the activities of the various firms at their home offices. An exception to this is the administration of the contract for most of the on-site utilities, which is being handled by the Portsmouth area office of the AEC. A. M. Kinney, Inc., Cincinnati, is in charge of this work.

After completion, the plant will be operated by Goodyear Atomic Corp., a subsidiary organized by Goodyear Tire & Rubber Co., Inc.

Skylight Provides Uniform Light Transmission Throughout the Year

Two pieces of pressed glass, hermetically sealed together with a sheet of Fiberglas between, form a new skylight unit manufactured by Kimble Glass Co., a subsidiary of Owens-Illinois Glass Co.

Developed in the Daylight Laboratory of the University of Michigan, the units have unusual light transmitting characteristics. Prisms on the inside of the top piece of glass are designed to vary the amount of daylight and solar heat transmitted into the interior, depending upon location of the sun. The second piece of glass distributes the light evenly. The sheet of Fiberglas, .002 in. thick, softens the light and augments the insulating effect of the vacuum between the two pieces of glass.

During the summer months when the sun is at its highest altitude, the prisms reflect as much as 53 per cent of the undesirable direct sunlight. In winter months, when the sun is at its lowest position, the unit transmits more light and solar heat.

The glass units, which measure 10⅝ in. square by 3 in. thick, are factory-assembled in aluminum grids, ready for installation. The entire assembly is weatherproofed and is said to be an efficient insulator. It is recommended that panels be installed on curbs and flashed to the roof surface.

Because of the light and heat controlling characteristics, the development opens new possibilities for the daylighting of flat deck industrial buildings without resorting to monitors or costly saw-toothed construction. Lighting studies show that a panel of moderate size in each bay will provide a satisfactory level of illumination for ordinary industrial tasks.

Coal-Burning Gas Turbine Closer to Commercial Use

Development of coal-burning gas turbines received added impetus as a result of a recent contract between Bituminous Coal Research, Inc., and American Locomotive Co. Under the agreement, Alco will continue development of the turbine for commercial applications, and will design a chassis for locomotive use. The program will be jointly carried out with BCR's Locomotive Development Committee.

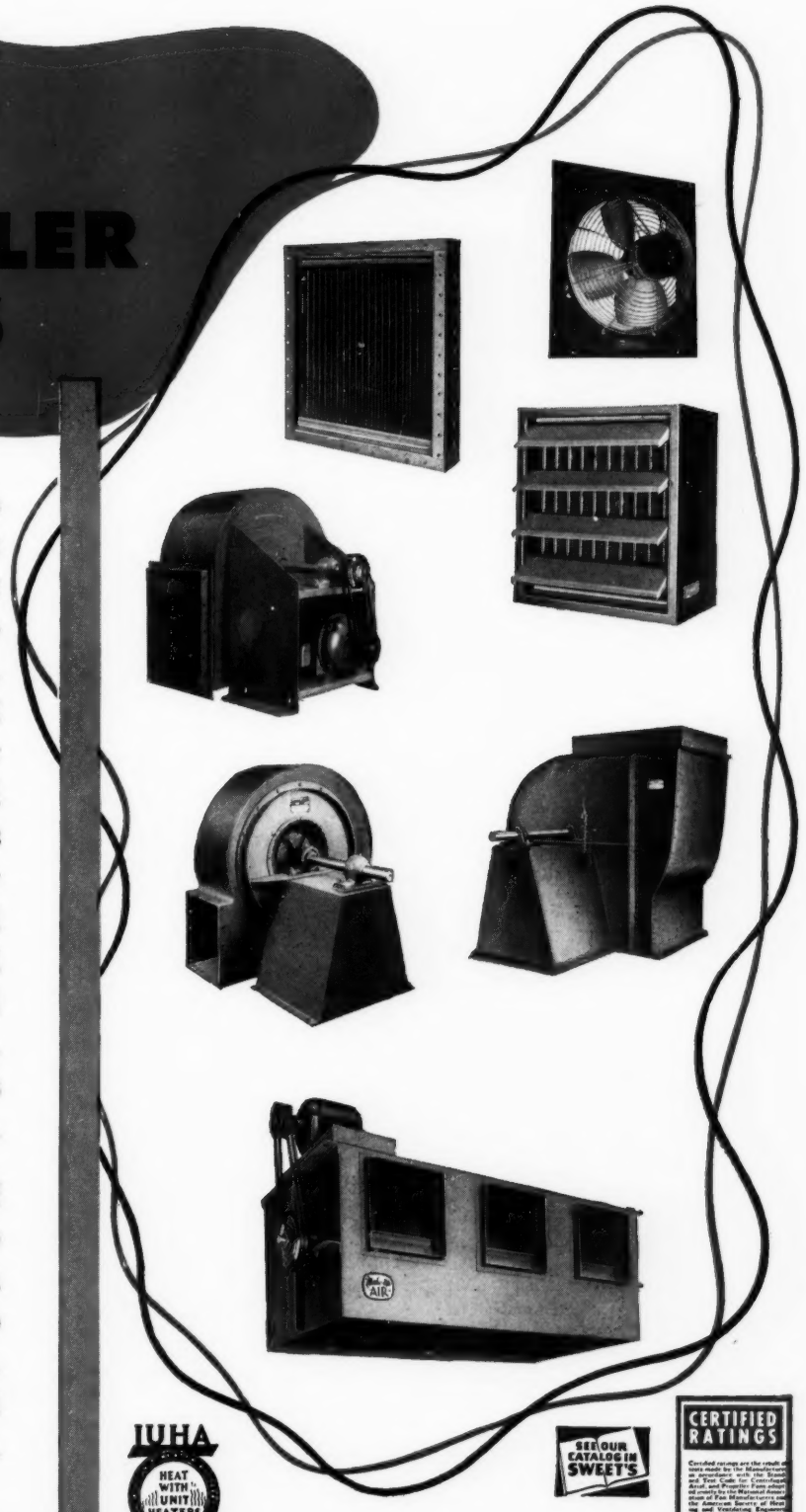
The committee, representing 9 major coal-carrying railroads and five of the nation's largest coal companies, began work on coal-burning gas turbines in 1945. Recently, a high temperature test program was completed at Alco's Dunkirk, N. Y. plant, with bituminous coal being used exclusively to fuel a 4250 hp turbine of a type contemplated for locomotive use.

Experiment Indicates Feasibility Of Transporting Coal by Pipeline

In the near future, pipelines may be used to transport coal from mine to market, just as gas and oil are now handled. Two years ago, in order to test the feasibility of such a system, Pittsburgh Consolidation Coal Co. earmarked more than a half million dollars to build an experimental coal pipeline system near Cadiz, Ohio. The project consisted of a 12 in. line approximately 17,000 ft long. Special crushing equipment, slurry preparation equipment, and pumps were developed for the pilot system. The coal is pulverized

(Continued on page 60)

nyb PROPELLER FANS



Propeller type ventilating fans deliver large volumes of air at low resistance and low current consumption. All wheels are machine balanced for smooth, vibrationless operation. Made in 2 types and 7 basic sizes to cover a wide range of industrial applications. Pressed steel panels provide rigid support and simplify installation. Totally enclosed motors mounted in heavy welded wire safety guard. Wheel diameters from 12 inch to 48 inch. Direct or belted drive. Capacities from 675 cfm to 23,500 cfm.

Penthouses for roof installation of ***nyb*** Propeller Fans can be furnished in 7 sizes. Louvers open and close automatically to protect fan against the weather. Separate louvers for wall mounting also available.

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FACTORY, LAPORTE, INDIANA

Coal Pipeline

—*Starts on page 58*

and mixed with water to form a slurry. At the end of the pipeline, it is dried before delivery to customers.

Latest comment on the experiment was in the company's annual report. It stated, "After eight months operation, the experimental project in Ohio has provided sufficient data to satisfy us that transmission of coal by pipeline can be developed economically. The product is essentially coal in a new form, and we are now proceeding to develop commercial aspects of providing sales outlets for it."

Scientist Discusses New Source of Light

Electroluminescence, a new method of producing light, has fascinating and challenging implications, according to Dr. E. F. Lowry, manager of Sylvania Electric Product's engineering laboratories. In discussing the new light source during a meeting at The Franklin Institute, April 1, Dr. Lowry demonstrated commercial as well as laboratory models.

As presently constructed, "the electroluminescent lamp takes the form of a sandwich in which a thin sheet of special phosphor, embedded in a suitable dialectric, is held firmly between two conducting plates, at least one of which is transparent glass. When an alternating electric voltage is applied to the plates, the phosphordialectric lights up."

According to Dr. Lowry, the new method is the first form of area lighting to be produced. With this system, whole panels of glass may be treated to provide even, cool lighting, without the use of bulbs, tubes, or filaments.

Institute Inaugurates Service For Researching Published Literature

To assist science and industry in streamlining the costly and burdensome job of researching existing published knowledge, Battelle Memorial Institute, Columbus, O., has established a technical information service.

Finding out "what has gone before" is the obvious question a good research man must answer when he undertakes a study, Battelle director Clyde Williams points out. With an estimated 60 million pages of technical matter being published each year, this has become a herculean task. "Our aim is to couple appropriate use of improved manual and machine documentation techniques with our long experience in the gathering and organization of research data."

"Present interest on the part of industry and government indicates a healthy growth for the new service. All the latest developments for the scientific processing of information will be brought to bear on the work, including standard business machine punch-card equipment, xeroradiography, microfilming, and pertinent electronic devices. A continuing study will be made on ways and means to improve existing information-processing techniques.

"The end result we are striving for is a technical information center that will save time and money for scientists and research organizations through the elimination of much needless duplication of research effort. The opportunities for so doing are tremendous. Some estimates put the current annual cost of literature searching at 300 to 750 million dollars, or from 10 to 25 per cent of the total 3 billion dollars spent by the nation on research last year."

Engineer Discusses Ion Exchangers For High Pressure Boiler Feedwater

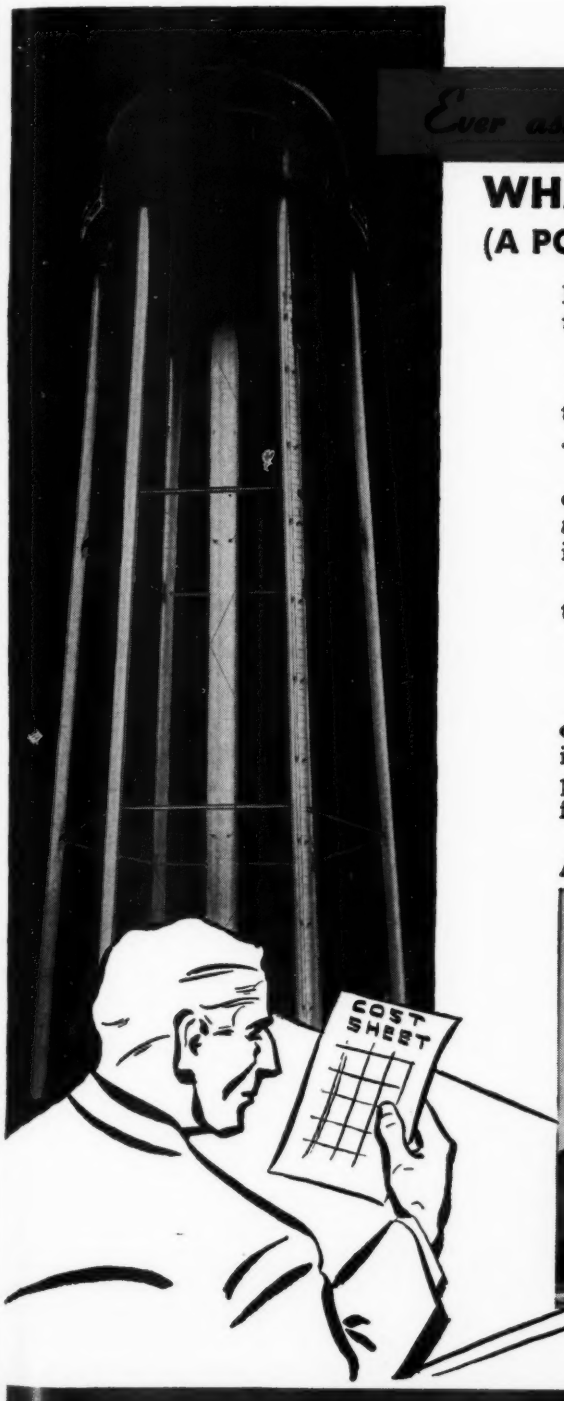
Experience in research of efficient boiler operation at high pressures has indicated the importance of maintaining low levels of silica content in boiler salines. In a paper presented before the American Power Conference in Chicago, March 27th, M. E. Gilwood, Director of Research for The Permutit Co., stated, "Higher silica levels result in solutions of silica in the steam and subsequent deposition on turbine blades in the low pressure stages of the turbine".

In the near future, at pressures of 1800 to 2400 psi and higher, the author predicted that maximum permissible silica content will be less than one ppm. "Since the make-up water is concentrated many times in the boiler, it has become common practice to specify that the treated make-up water should contain no more than 0.1 ppm of silica."

Mixed bed and two-step demineralization by ion exchange are two processes that can be used to reduce dissolved silica and solids to meet exacting specifications for high pressure feedwater. According to Gilwood, dissolved silica can be reduced to levels approaching 0.01 ppm.

MODELS SIMPLIFY SPACE CALCULATIONS

To assure adequate space, General Electric planners set up the complete manufacturing, testing, and shipping processes in scale model form before fixing any building dimensions for a $25 million plant in Rome, Ga. Upon completion of the plant this summer, power transformers will be entirely assembled by production line methods for the first time.



Ever ask your **TREASURER . . .**

WHAT *HE* THINKS OF YOUR TANKS?

(A POSEY IRON Bid Might Interest Him and YOU)

Most treasurers are apt to put cost first. And cost is certainly *not* the only factor to consider when buying steel plate construction.

But —

It's good engineering as well as good financial policy to refuse to pay a penny more for tanks . . . or pressure vessels . . . or stacks . . . than is necessary fully to meet *the standard desired.*

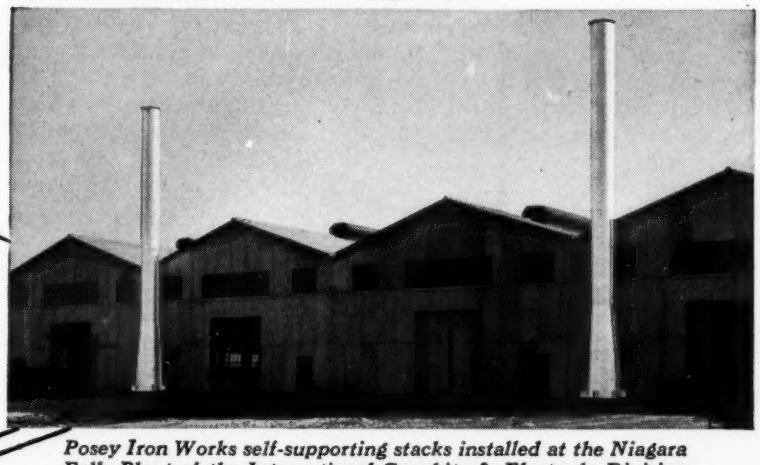
The Posey Iron Works offers you 42 years of money-saving experience over the full range of steel plate fabrication . . . *practical* engineering and design service that concentrates on structural integrity and safety rather than on cost-padding "frills".

That's why we say a Posey Iron bid might interest your treasurer as well as you.

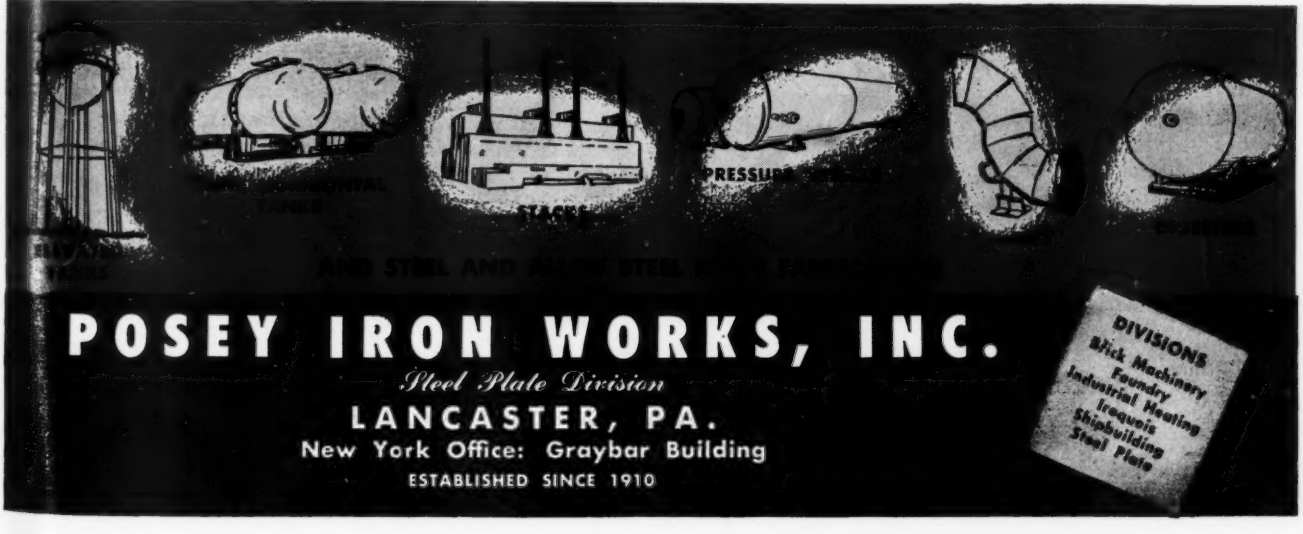
Edges of Plates Properly Prepared for Welding . . .
Electrodes Carefully Selected

Perhaps more than any other production step, welding influences tank costs and structural soundness. Every electric welder in Posey's shops is fully qualified. No plate is welded without proper preparation of edges . . . electrodes are chosen after careful consideration of requirements.

Posey meets all standard codes including ASME; API-ASME; API. Consultation does not obligate you.



Posey Iron Works self-supporting stacks installed at the Niagara Falls Plant of the International Graphite & Electrode Division of Speer Carbon Co. Height: 50 ft. Diameter: 3 ft.



POSEY IRON WORKS, INC.

Steel Plate Division

LANCASTER, PA.

New York Office: Graybar Building

ESTABLISHED SINCE 1910

MEN IN ENGINEERING

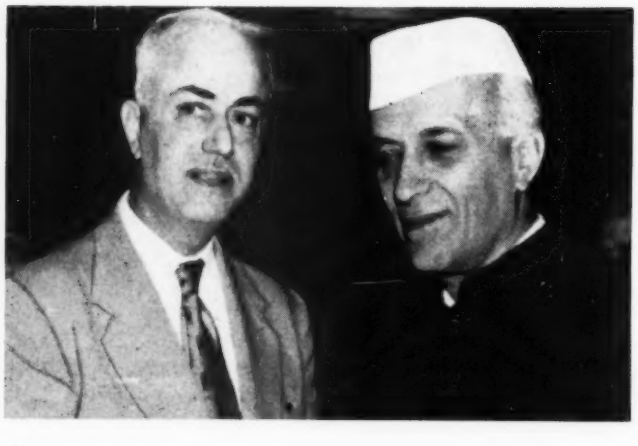
★ A. K. Ferguson is appointed v-p in charge of industrial engineering for Walter Kidde Constructors, Inc.

★ Dr. O. Kay, a specialist in inorganic industrial chemistry, recently joined the staff of Sam Tour & Co., Inc. He will be director of the firm's chemical dept.

★ The establishment of an advisory committee consisting of two scientists and an economist, all active in the nation's atomic energy program since its inception, is announced by Walter Kidde Nuclear Laboratories. The committee consists of Dr. J. R. Oppenheimer, wartime director of the Los Alamos, N. Mex., laboratory which developed the atomic bomb; A. Sachs, consulting economist and a director of Lehman Brothers, investment bankers; and Dr. H. C. Urey, winner of the Nobel Prize in Chemistry in 1934 for the discovery of deuterium (heavy water). The purpose of the advisory committee is to consult with the laboratories management on long-range planning for the development of commercial atomic power and on the application of nuclear technology to industrial problems, according to Henry K. Norton, president of the company. The members of the advisory committee have expressed their enthusiasm on the possibility of developing commercial atomic power under privately-financed auspices in the foreseeable future.

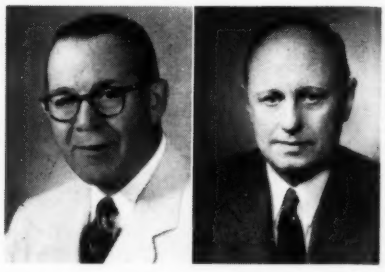
★ Announced recently by Dr. F. W. Cunningham, was the founding of the first private business to be wholly devoted to the design and manufacture of non-circular gears. Base of the business is the automation, by Dr. Cunningham, of a standard gear shaper now being operated by a motion picture film. Purpose of the business is to provide engineering and manufacturing help to any who need such services in connection with non-circular gears. Those interested can reach him at 56 Hubbard Avenue, Stamford, Conn. Dr. Cunningham is a resident consultant to Arma Corp. and continues in that capacity.

★ Dr. Scott Turner, consulting mining engineer, is elected president of the American Institute of Consulting Engineers.



AMERICAN ENGINEERS AND TECHNICAL SKILLS received glowing tribute from Prime Minister Nehru (right) at the dedication of the first unit of India's "TVA"—the Bokaro Steam Power Plant. (CE-Mar. '53, p 64). At left is Harry A. Kuljian whose firm designed and built the plant.

★ Robert J. Stormont, vice-president and general manager of The Wickes Boiler Co., is named chairman of a newly organized Saginaw Valley Sub-Section of the American Society of Mechanical Engineers. Max Riebenack, sales manager of Industrial Brownhoist Corp., is vice-chairman.



STORMONT KINNARD

★ I. F. Kinnard, engineering manager of the Meter and Instrument Dep't, General Electric Company, is awarded the 1952 Lamme Gold Medal "for his outstanding contributions in design and developments in instrumentation and measurements." It will be presented during the Summer General Meeting of the American Institute of Electrical Engineers at Atlantic City, June 15-19.

★ Burns & Roe, consulting engineers to the Rockland Light and Power Co., sponsored a series of smoke tunnel tests at New York University to determine how a new 66,000-kw unit would affect atmospheric conditions in the residential section surrounding the plant. "As a result of these tests," Mrs. Roe stated, "we can confidently predict that there will be no worsening in air-pollution conditions when the new unit goes into operation." Modifications which will improve present conditions, Mr. Roe said, consist of extensions to the existing stacks and the use of a tapered stack design.

★ Charles F. Doerr resigned his position as chief consulting engineer of the General Stores Supply Office, Department of the Navy, to accept the appointment as secretary and executive officer of the Engineers Club of Philadelphia.

★ Frank L. Phillips, formerly ass't chief engineer of Voorhees, Walker, Foley and Smith, now manages the New York sales office for Cleaver-Brooks Co.

★ M. Nielsen, recently elected a vice president of The Babcock & Wilcox Co., is placed in charge of the manufacturing dep't of the Boiler Div.

(Continued on page 64)

Only DRAVO *Counterflo* Space Heaters offer you these 5 exclusive features:

Ideal for heating large open spaces in industrial, commercial and educational buildings, standard Dravo *Counterflo* Space Heaters have five exclusive advantages over other warm-air space heaters.

1 The Dravo *Counterflo* combustion method takes place in a stainless steel combustion chamber. The exhaust gases from combustion are "whirl-cooled" through two sets of economizer tubes. This four-pass heat transfer results in a minimum heating efficiency of 80%.

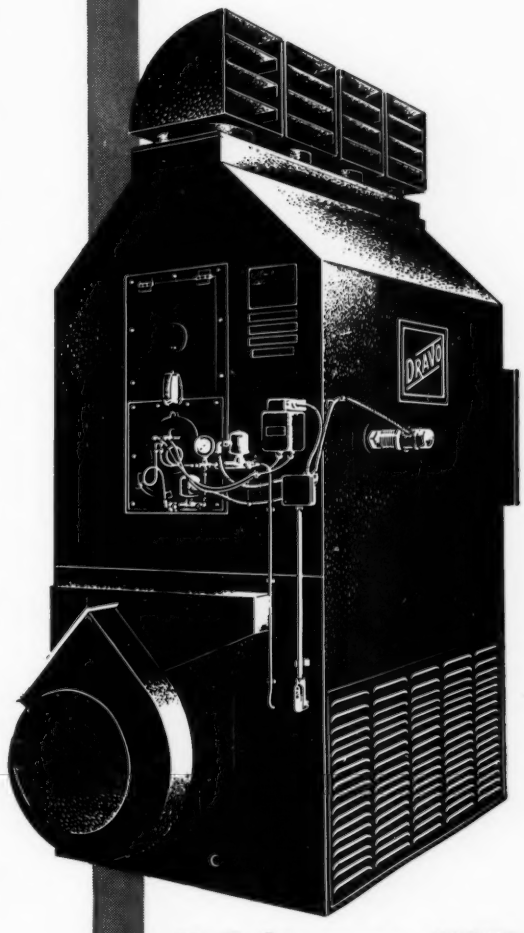
2 One rotor shaft operates all heater fans, thus co-ordinating exhaust, air-intake and heat-discharge systems.

3 Air for combustion is provided by main supply fan; volume and velocity are controlled by an adjustable damper.

4 Approved by American Gas Association and listed by Underwriters' Laboratories, Inc.; Dravo Safety Control Circuit is accepted by Factory Mutual Engineering Division.

5 Burners are designed by Dravo Engineers for top efficiency. Heaters burn gas or oil; burners are interchangeable to take advantage of fuel savings by using the most economical source of supply or in times of shortage the most available fuel.

Dravo *Counterflo* Space Heaters in addition to comfort heating are easily adapted to heat curing and process drying, tempering of replacement air and summertime ventilation. Dravo Heaters can also be tied in with air conditioning systems by making use of the same ductwork.



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Manufactured and sold in Canada by Marine Industries, Ltd., Sorel, Quebec. Export Associates: Lynch, Wilde & Co., Washington 9, D.C.

Men In Engineering

—*Starts on page 62*

★ Durando Miller, Jr., is promoted to the position of ass't technical manager for The Permutit Company.

MILLER REEVES

★ Frank E. Reeves heads the new Los Angeles sales engineering organization of the Automatic Switch Company.

★ Gordon C. Jacoby, consulting engineer, designed the new Allen B. Du Mont Laboratories, Inc., plant for the manufacture of cathode-ray instruments for industrial and defense use. It is a modern one story steel and tile structure, with 18-foot ceilings, completely sprinklered. Located in Clifton, N. J., it adjoins DuMont's main plant.

★ Francis K. McCune is appointed general manager of the General Electric Company's Atomic Products Division. In his new capacity he will be responsible for the company's extensive atomic energy activities, and will also be responsible for co-ordinating company activities in the nuclear field with the Atomic Energy Commission.

★ F. L. Egan joined Fischer and Associates, registered engineers, 5209 Euclid Avenue, Cleveland, as project engineer. Egan formerly was associated with The H. K. Ferguson Co., which he joined in 1950 as project engineer in charge of reactivation of the Federal Arsenal at Milan, Tenn.

OBITUARY

★ Funeral services were held in Los Angeles April 4 for J. Gordon Turnbull, consulting engineer for the design and construction of the River Rouge plant of Ford Motor, the Knolls Atomic Laboratory, the Canol Project, many General Motors plants, and other major industrial installations throughout the world.

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DOUBLE SEATED DIAPHRAGM CONTROL VALVES

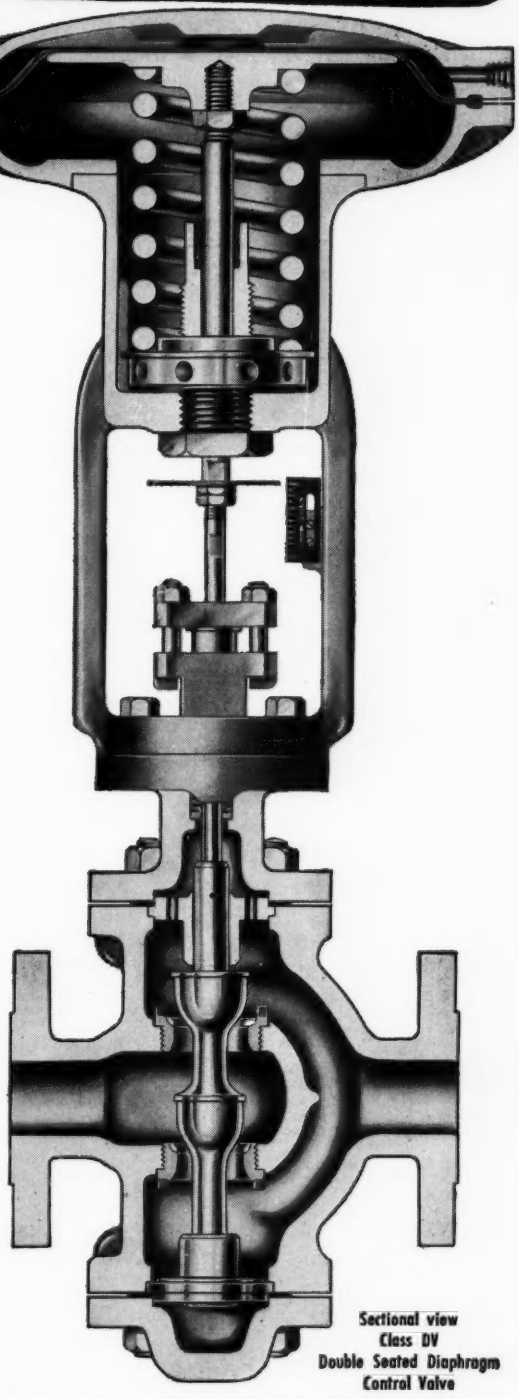
Calling a spade a spade you've got a "royal flush" of features in these new Valves designed for use with control instruments.

Their "Flow-Line" Contoured Bodies have ISA standard face-to-face dimensions and high capacity, low turbulence and minimum body pressure drop characteristics.

A new type, top and bottom guided construction is self-aligning and non-binding regardless of uneveness of bolt tightening.

Standard, integral stellited seating surfaces are recommended for steam service to reduce seat ring thread corrosion. Renewable, interchangeable seat rings also furnished where desired and may be easily replaced without removing valve body from the line. Elaborate grinding at high temperatures is completely eliminated.

With these Valves, you get as *standard equipment*, features heretofore only obtainable in expensive, specially designed valves.



Sectional view Class DV Double Seated Diaphragm Control Valve

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Monroe, La.
New Orleans, La.
New York, N. Y.
Orlando, Fla.
Philadelphia, Pa.
Pittsburgh, Pa.
Ponca City, Okla.
Providence, R. I.
Richmond, Va.
Rochester, N. Y.
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Salt Lake City, Utah
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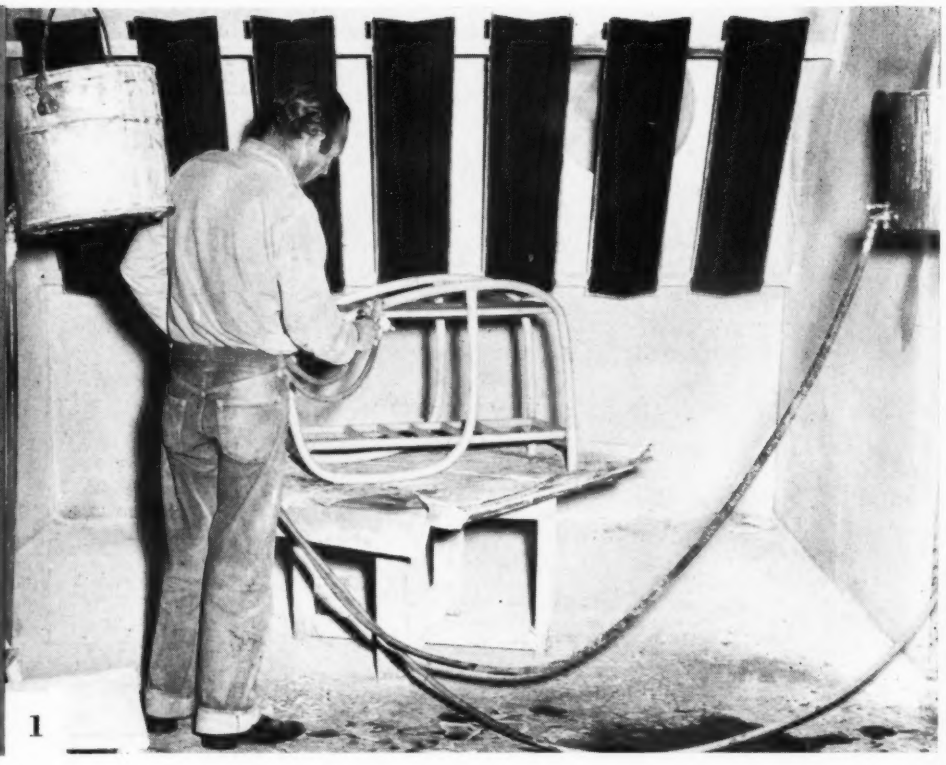


FIG. 1
CONVENTIONAL PNEUMATIC-SPRAY UNITS, EQUIPPED WITH INEXPENSIVE HEATING ACCESSORIES, MAKE POSSIBLE ECONOMICAL HOT-SPRAYING OF LACQUERS AND THERMOPLASTIC COATINGS.

FIG. 2
STANDARD STEAM-HEATING ACCESSORIES, AS ILLUSTRATED, PERMITS THE UTILIZATION OF STEAM PRESSURE IN THE APPLICATION OF SOME ORGANIC MATERIALS.

FIG. 3
SPECIALLY-INSULATED SPRAY GUN OF THE TYPE SHOWN HERE ENABLES A WORKER TO APPLY A THERMOSETTING COATING MATERIAL WITHOUT DANGER OF BURNS WHERE STEAM IS EMPLOYED FOR SPRAY FINISHING A PRODUCT.

Evaluation of Heat-Finishing Equipment

FRANK CHARITY

There are three types of heat-finishing equipment capable of saving time and materials in the application of organic coatings to various industrial products. These types are commonly known as flame-spray, heat-spray (hot-spray), and steam-spray units. Each has very definite advantages in certain circumstances, but none should be regarded as an invariably desirable substitute for other types of coating equipment.

In general, flame and hot-spray units are preferred in the application of thermoplastic (heat-softenable) compositions, while steam-spray units are most satisfactory for the deposition of thermosetting (heat-hardenable) materials.

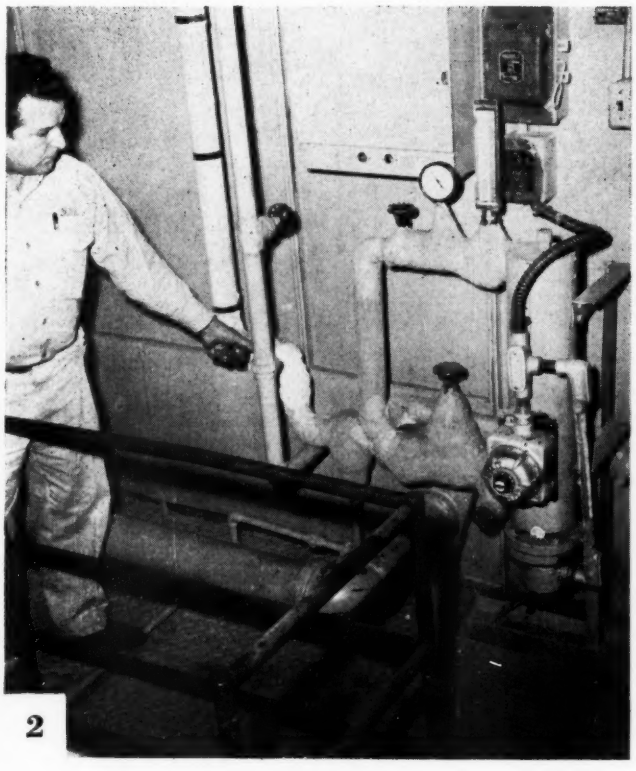
Flame Finishing

Flame finishing consists of spraying thermoplastic powders through an open gas flame so that the powders will be homogenously heat-fused on a surface. Because the sprayed coating materials are rapidly cooled and solidified by open air, this method permits the efficient buildup of exceptionally thick coatings with minimum porosity, maximum adhesion, and excellent chemical inertness.

However, the process is more or less limited to the application of coating materials like Polythene or polymerized ethylene (which do not oxidize readily at elevated temperatures) on steel and other surfaces which are not easily damaged by temperatures below 500 F.

First successful flame-spray equipment was developed by W. B. De Long and E. V. Peterson of American Agile Corp., Cleveland. The principal component is a spray gun capable of producing a relatively long, low-temperature flame. Thermoplastic coating particles suspended in air are drawn into the gun by means of a venturi, then expelled from the gun through a small tube, which is concentric with a larger tube that expells a fuel gas (either acetylene or city gas). A long, low-temperature flame is produced because the fuel gas receives no oxygen for combustion until it emerges from the gun and comes in contact with open air.

A commercial carburetor-type feeder, operated with a small amount of low-pressure air, provides the air-powder mixture for the gun. This mixture is drawn into the gun's venturi by means of pressure from a standard coating compressor. Valves on gas and air lines regulate the volume of gas and control the velocity of air-borne powders, while a suction-



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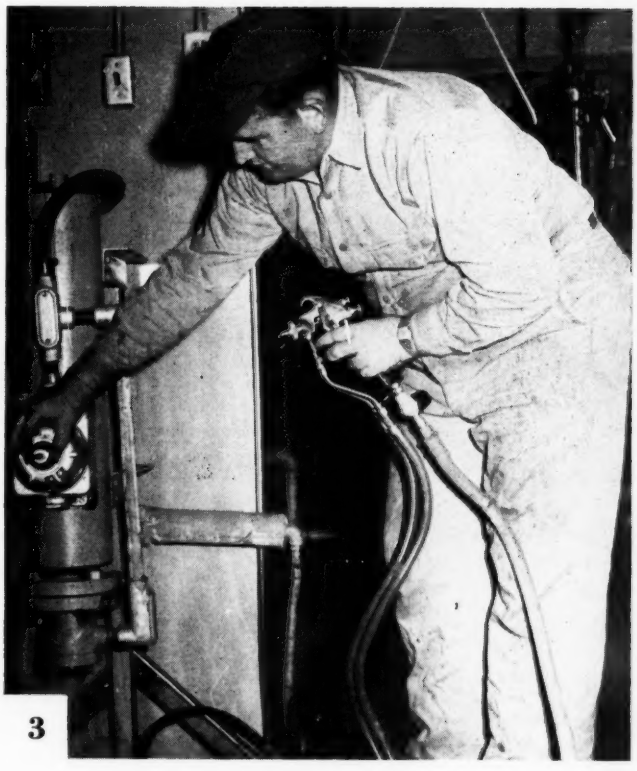

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relief port and closure permit the on-off control of the powder flow.

In many circumstances, preheating a deposition surface is desirable to prevent the rapid chilling of flame-sprayed coating particles, since the coating will not flow properly when cooled too rapidly. This is usually accomplished by closing a pinch valve to bypass the carburetor air supply, then wielding the gun like a heating torch.

Materials are cleaned, degreased, and roughened in a conventional manner prior to flame-finishing operations. Workers with experience in the operation of conventional coating equipment can usually master the technique of a flame-spray gun in a matter of minutes.

Areas of approximately 2 x 3 ft are covered in a series of gun movement by applying overlapping strips, each of which is about 2 in. wide, at a torch traverse speed of 0.5 to 2 fps. As soon as one pass is made over a given deposition area, a duplicate pass can be started. The total number of passes, over the same area, determines the thickness that will characterize the finish coating.

Flames about 8 to 12 in. in length normally give the best results, and the target, or deposition surface, is usually about 2 in. from the tip of the flame. Quite often, flame-sprayed particles appear to be unmelted at the time they strike a deposition surface. But, when work is being done properly, they will quickly fuse and lose their identity. No intermediate heating of deposition surfaces is necessary in most cases because the flame-spray gun will maintain proper temperatures if passes are made as described. However, it is sometimes necessary to pause between passes in finishing very small areas to avoid overheating coating materials on the surfaces.

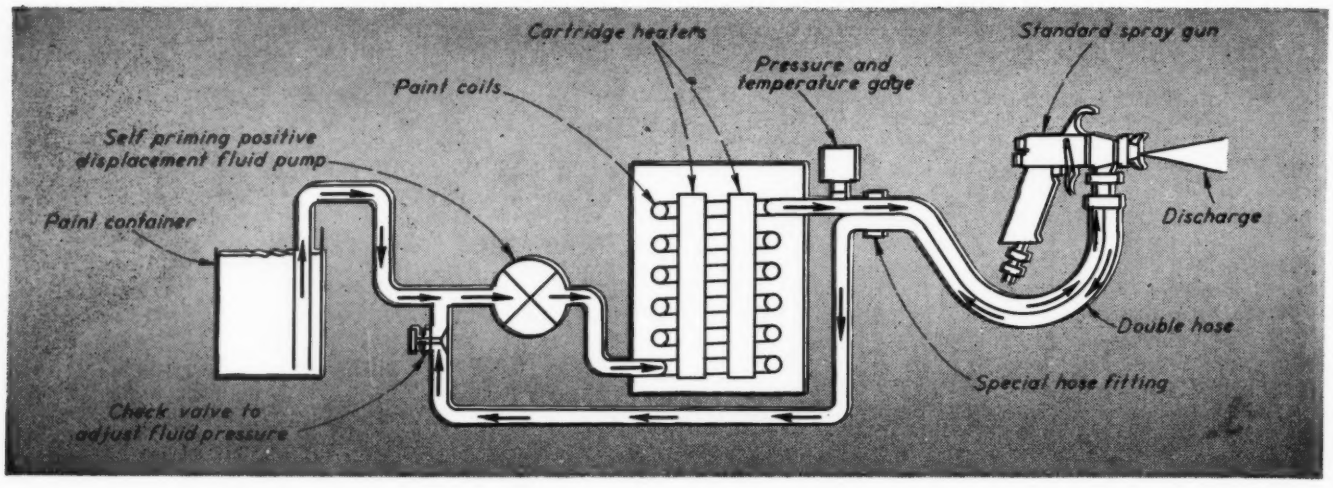
Where a 0.04 in. thick coating is required, surfaces can be flame finished at the rate of about 16 sq ft per hr. As a rule it is desirable to use a water quench in cooling each product that has been flame-finished because resultant crystallization will greatly increase the toughness and durability of the coating.

Despite the fact that the use of fuel gases are necessary, flame finishing is not quite as expensive as most organic coating methods because it eliminates the need for solvents or thinners in coating materials and supplemental drying or baking facilities. However, there are many limitations as to the types of thermoplastic materials and the color effects that can be obtained with flame-spray equipment. Therefore, this process is usually specified only where a product coating of extreme chemical inertness is required—for example, to prevent the deterioration of metals in the presence of strong acids and alkalies.

Hot Spraying

Hot spraying can be distinguished from flame spraying in that it involves heat without open flames. The general purpose is to reduce the viscosity of lacquers and other thermoplastic finishing materials so as to minimize the need for special solvents or thinners and drying or baking facilities.

Aside from the fact that they can greatly reduce the cost of conventional coating techniques without



DETAILS OF PRINCIPAL EQUIPMENT ARE SHOWN SCHEMATICALLY IN THIS TYPICAL SETUP FOR THE HOT-SPRAYING OF ORGANIC LACQUERS AND THE MANY OTHER THERMOPLASTIC COATING MATERIALS ON THE MARKET.

necessitating a large investment in new finishing equipment, hot-spray facilities can be used in connection with many coating materials and deposition surfaces that would quickly oxidize or burn in the presence of open flames.

Economy-minded Europeans (especially in the Scandinavian countries) have been using hot-spray equipment to apply virtually all lacquer-type coatings to industrial products since the early days of World War II. But, as yet, only a few American manufacturers are doing such work.

Virtually all commercial types of spray guns, pressure tanks, compressors, and air lines are suitable for hot-spray finishing when they are properly equipped with heating accessories, now available in two different types:

(1.) Air-heater type with one electrical heating unit on the air line leading into a pressure tank and a second heating unit on the line that feeds a spray gun. Both heating units are thermostatically controlled for consistent coating temperatures of 170 to 300 F.

(2.) Circulating-heater type using a cartridge-heated coil through which a coating material is pumped to a spray gun for output temperatures in the same general range as provided by the air heater unit.

Special hot-spray coating materials with relatively small quantities of volatile solvents are now being produced by most major manufacturers of organic finishing compounds. These materials are a bit more expensive than conventional coating dispersions because of the high solids content, but that is a negligible item, for their use involves relatively slight material losses.

Actual ratio of solids to solvents in a hot-spray coating solution, prior to application, depends on the temperatures and pressures which can be employed. For example, where 10 gal of lacquer might be thinned with two gal of solvent for spraying at room temperature and with an air pressure of 16 psi; only one gallon of thinner is needed to apply the same material with 11 psi when the coating is preheated to 180 F.

General technique of spraying a heated coating material is essentially the same process that would be used in spraying the same compound without heat. However, a hot-spray coating can be applied with much greater speed and 50 per cent less air pressure, because heated thermoplastics have better viscosity for finishing purposes. They can be applied also as films with thicknesses of about 2.5 mils (where one mil would be the optimum thickness of a conventional organic coating film) without danger of sags, blisters, or related defects.

Hot-spray coatings can be successfully applied without regard for temperature and atmospheric conditions, which would ordinarily preclude the use of organic finishing solutions where no air conditioning facilities are available.

Little heat is conveyed by hot-spray coatings to the deposition surface because the coating particles are rapidly cooled by air after they emerge from the nozzle of a spray gun.

Solvent losses due to hot spraying are relatively high, because the temperature of a heated finishing solution is near the boiling point of its volatile constituents when it emerges from a spray gun. However, the actual quantities of vapors dispersed in the atmosphere are comparatively slight—not only because smaller quantities of thinner are used, but because the sprayed solids are relatively dense and will not rebound like particles sprayed in a conventional manner. This is significant because coating materials are conserved while the more or less toxic vapors that might be inhaled by finishing personnel

are reduced to that point where they are not injurious.

Experience has shown that where first quality heating accessories are properly used and maintained, the fire or explosion hazard associated with hot spraying is less than could be expected in spraying solvent-dispersed coatings at room temperature.

Deposition surfaces to be finished with hot-spray equipment should be clean. But, they do not require the roughening essential to adhesion of many organic coatings because the preheated thermoplastics are subject to no more than 15 per cent shrinkage (whereas lacquers sprayed at room temperature shrink about 40 per cent).

Short baking or drying intervals are sometimes necessary to assure the complete solidification of a hot-spray coating in the least possible amount of time. This rarely amounts to more than 25 per cent of the time that would be required to solidify a solvent-dispersed coating applied without heat.

Over-all savings due to the use of hot-spray equipment include 10 to 25 per cent lower material costs, 10 per cent lower labor costs (fewer rejects), and 5 to 25 percent lower power costs (less compressed air, less heat for drying or baking purposes).

Steam Finishing

Process of steam finishing consists of using steam pressure, rather than pneumatic pressure, to spray coating materials. It is especially economical in plants where the necessary steam can be obtained from existent boiler facilities.

Thermoplastic coatings, as a whole, cannot be steam-sprayed because small quantities of moisture could seriously alter their finishing properties. Thermosetting coatings, on the other hand, are not usually affected by small quantities of moisture and will solidify with greater speed if exposed to the heat of steam as they are atomized.

It was initially developed by du Pont and involves the preliminary processing of boiler steam through a separator to remove all but about one per cent of the moisture. Next, a small electrical superheater is generally used to boost the temperature of the dehydrated steam which is then piped to a tank containing the coating solution. Finishing operations are accomplished with a manual gun in a booth, the same as with pneumatic spray equipment.

Carefully-insulated spray guns are necessary to avoid burns among workers applying steam finishes. However, the cooling action of open air permits very little heat to be conveyed to a deposition surface.

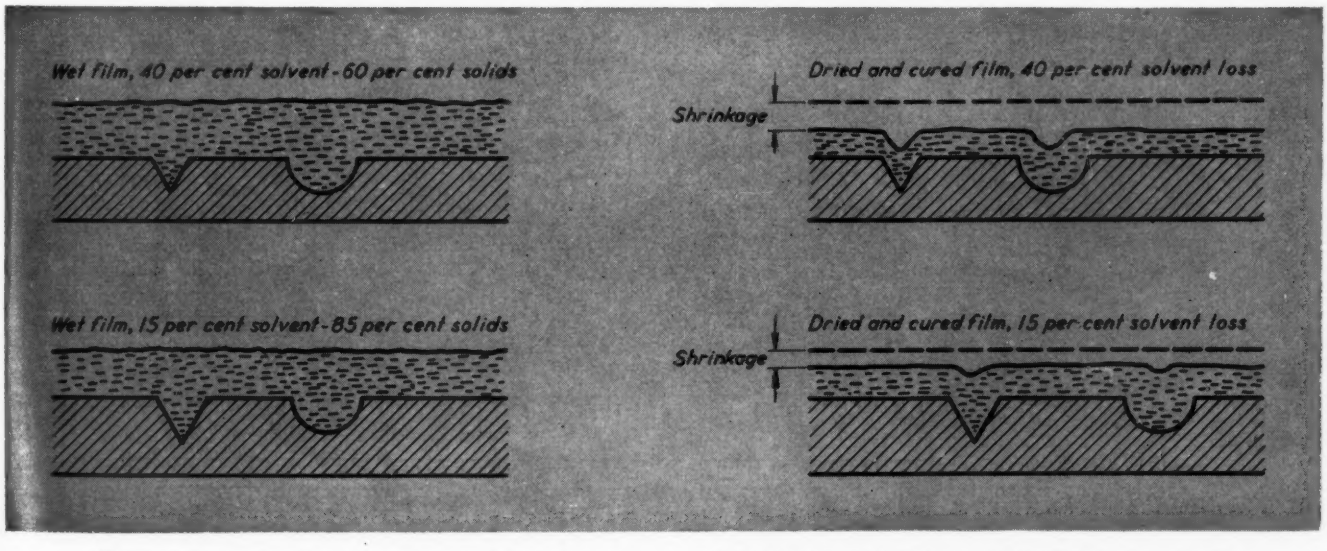
The one per cent moisture content of the steam serves the primary purpose of increasing the fluidity of the thermosetting coating solution. Evaporation makes it impossible for any substantial portion of the moisture to reach the surface being coated.

Steam heat inaugurates the exothermal reaction that causes a thermoset to polymerize, or solidify, and this is desirable to the extent that the need for baking equipment is consequently minimized or eliminated. However, a few difficulties have been experienced in the clogging of spray-gun nozzles with prematurely-polymerized coating materials. This necessitated the immersion of clogged nozzles in stripper solutions and the use of spare nozzles.

Boilers to provide pressure for finishing purposes should have capacities of 50 lb per hr for each spray gun. Separators, superheaters, piping, and other facilities (with the exception of insulated spray guns) are more or less standard.

Coatings applied with steam-spray equipment are not necessarily better than coatings of the same materials applied with other types of equipment. However, they are much less expensive.

Low cost of steam finishing operations is primarily attributable to the fact that small quantities of thinner are required in coating materials, and steam is often available at a very low cost.



SHRINKAGE COMPARISON BETWEEN COLD-SPRAY, TOP, AND HOT-SPRAY BOTTOM. LESS SOLVENT IS EMPLOYED IN THE HOT-SPRAY METHOD, WHICH REDUCES THE AMOUNT OF SHRINKAGE AS MORE SOLID MATERIAL IS SPRAYED.

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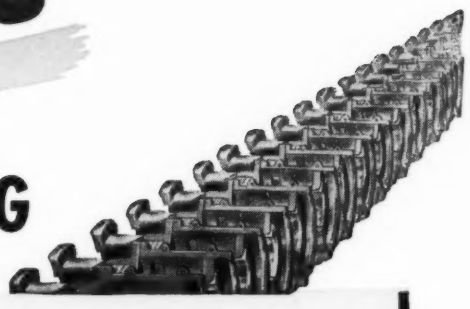

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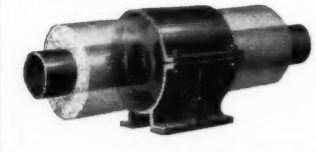

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FRANK E. REEVES
Consulting Engineer

Indicators and recorders are very commonly used for measuring temperatures of stator windings on almost all sizes and types of a-c generators, synchronous motors, and synchronous condensers. There is widespread agreement about the desirability of maintaining a close watch on temperatures of such armatures as a basis for safe loading.

With speeds of rotors up to 1800 rpm, very little trouble was ever experienced with the field windings, and there seemed to be no good reason for an investment in rotor temperature measuring equipment. The introduction of the 2-pole, 60 cps, 3600 rpm generator poses new problems in rotor design because of the extremely high centrifugal forces produced at this speed. The actual occurrence of field failures justify reconsideration of monitoring field failures justifies reconsideration of monitoring warning.

The most common cause of rotor failure is locking of the windings in place by centrifugal forces, preventing the windings' normal longitudinal expansion due to heating. If a machine has had time to cool prior to re-starting, both the field windings and the rotor steel are at room temperature when the unit is again brought up to speed. The field is then energized, and the machine is loaded. The field windings warm up first as a result of the field current. The temperature of the rotor body then rises through the transmission of heat from the windings. Expansion of the field windings (usually copper or aluminum bars) therefore takes place before the expansion of the rotor.

There is obviously a time lag between the expansion of the windings and that of the rotor steel. In addition, the coefficients of thermal expansion for copper and steel, or for aluminum and steel are not identical. The result is a differential expansion.

Rotors are normally designed so that such differential expansion can occur without causing distortion of the windings or undue stresses on the end rings. However, with the windings in the slots locked in place by centrifugal action, free thermally caused movement of the windings with respect to the rotor body cannot take place. The result is deformation or a "permanent set" in the windings.

Each cycle of loading and cooling leaves its mark in the form of an increment of deformation. After several such cycles there is a danger of short circuited turns which cause heating at an accelerated rate and bring about more rapid deformation. If such deformation is not symmetrical, excessive vibration may result. Many 3600 rpm machines have had such rotor trouble.

It appears advisable to provide for motor temperature measurements on all 3600 rpm synchronous generators and motors with the possible exception of small units. A rating of 10,000 kw may be used as a dividing line, with all units of that size or larger equipped with either temperature indicators or recorders. However, even on the smaller units, and on slower speed machines, rotor temperature indicators might be recommended in order to provide a complete picture of machine temperatures. Machines can be much more efficiently loaded if field temperatures are carefully watched.

Thermocouples, or more commonly, resistance elements, are embedded in the windings for measurements of stator temperatures. The connections are brought out to terminal boards and indicating or recording potentiometers or ohmmeters, scaled in degrees C, are connected to the terminal boards.

For measurements of rotor temperatures during operation, the problem is somewhat different. Thermocouples or resistances embedded in the rotor windings would require special slip rings which would be impractical.

Instrumentation Principles

There are two methods in common use for measuring rotor temperatures while the machine is turning. One employs the fall of potential principle; the other, the double Kelvin bridge principle.

The fall of potential principle is often called the "voltmeter-ammeter" method for measuring d-c resistance since these two instruments are the basis of such measurements. By Ohm's Law, resistance changes of the rotor windings are calculated from the changes observed in the voltmeter and ammeter

readings. See Fig. 1. Temperature is coordinated with the resistance by the relation:

$$R_2 = R_1 [1 + a (t_2 - t_1)]$$

where R_1 = resistance, in ohms, at temperature t_1 in degrees C

R_2 = resistance, in ohms, at temperature t_2, in degrees C

a = resistance-temperature coefficient for the material used in the windings

For copper: a = .00393 For aluminum: a = .00403

The above relation is not exact, but it is sufficiently accurate for the temperatures and resistances involved in machine rotors.

Indicating and recording instruments especially designed for temperature measurement by the fall of potential principle are now available. These instruments indicate or record temperature directly.

The indicating instrument senses both voltage and current. See Fig. 2. The process of dividing one parameter by another in one dynamometer type

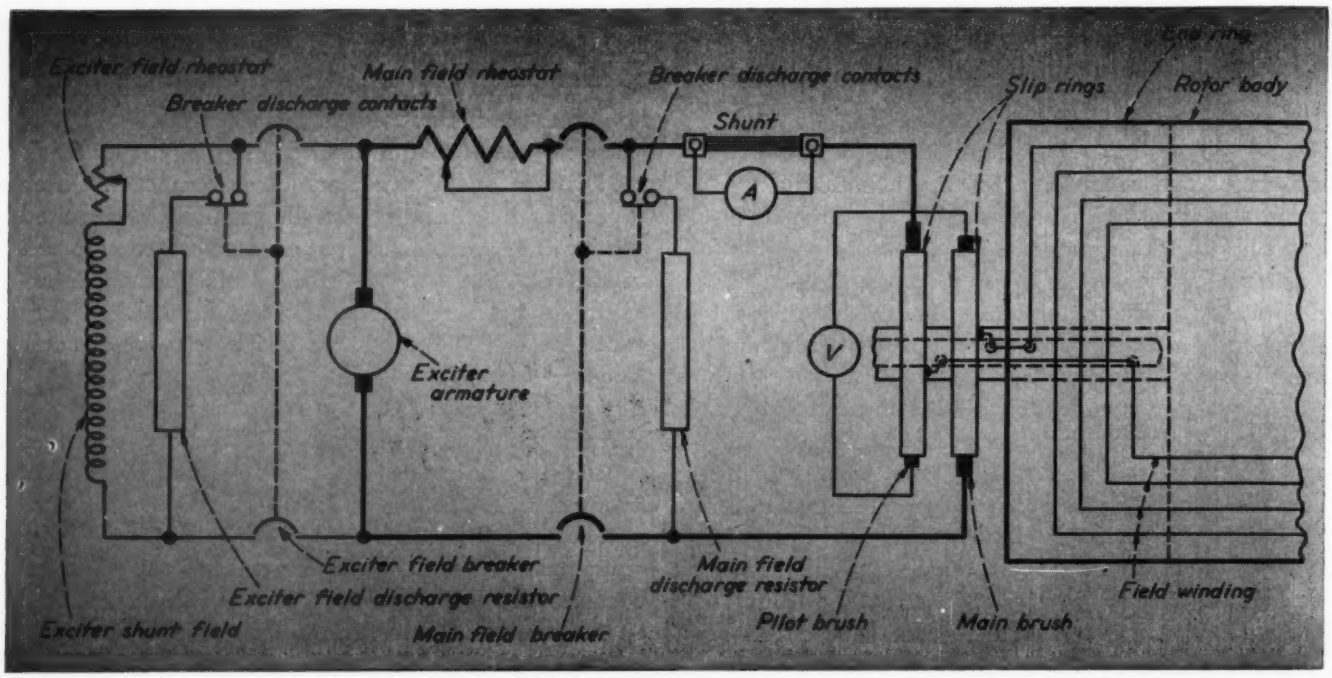


FIG. 1—PILOT BRUSHES ARE USED IN THIS ARRANGEMENT FOR THE VOLTMETER-AMMETER METHOD OF MEASURING ROTOR TEMPERATURE BY THE FALL-OF-POTENTIAL PRINCIPLE. TEMPERATURE IS COMPUTED FROM RESISTANCE.

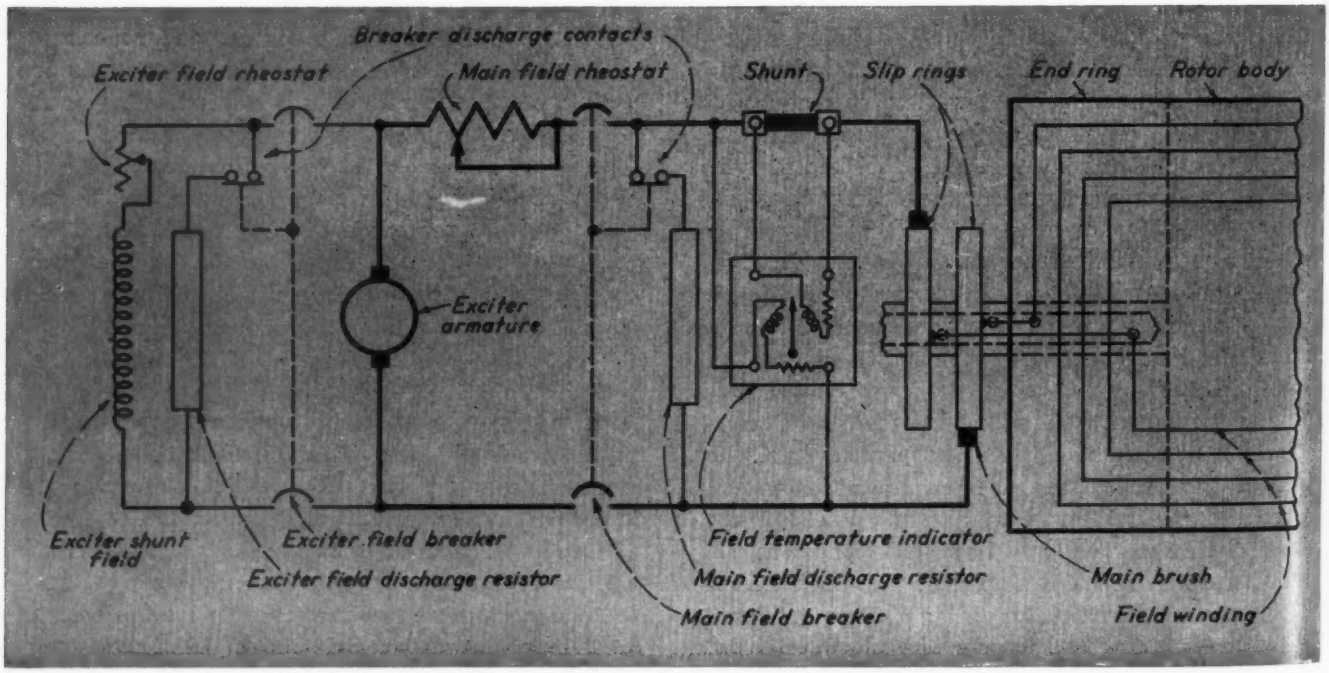


FIG. 2—INDICATING INSTRUMENT CONNECTED AS SHOWN READS OR RECORDS DIRECTLY IN DEGREES, ELIMINATING ALL COMPUTATIONS. CORRECTIONS ARE MADE FOR EXTRANEOUS FACTORS SUCH AS BRUSH DROP AND LEAD DROP.

instrument is accomplished by a special arrangement of two actuating coils so that their fluxes create the properly related torques throughout the scale range.

It was formerly believed that pilot brushes were needed for the potential connections to the voltmeter, Fig. 1, or voltage-detecting coil in the resistance measuring device, Fig. 2. In this manner, it was reasoned, the error in resistance due to brush resistance would be eliminated. However, because the pilot brushes carried only an extremely small current, a film quickly built up on the surfaces of the brushes and on the slip rings themselves. For this reason, resistance and temperature measurements using the pilot brushes were found to be erratic and inaccurate. Consequently, pilot brushes are no longer used for these measurements, and the potential connections are made across the main brushes, Fig. 2. (The much heavier currents carried by the main brushes constantly burns off any film which might build up.)

Manufacturers of instruments for measuring rotor temperatures obtain adequately accurate values of brush drop and brush resistance under full load conditions from the machine manufacturers. The instruments are then compensated for this factor. In general, total brush drop may be estimated with reasonable accuracy at 2 v. Because the brush resistances are usually only a small percentage of the resistances of field windings, errors in estimates of brush resistance have only a very small effect on the temperatures indicated by the instrument. The real value of the readings is for day-to-day and hour-to-hour comparison under similar loading conditions. An increase in temperature of the rotor windings over a period of time and under similar loading conditions will indicate that trouble is developing in the field.

To install an indicating temperature instrument on an existing machine rotor, the same shunt which is used for the field current ammeter may be used provided it is a 100 or a 150 millivolt shunt. If it is rated 50 mv, an extra shunt should be added to the circuit, preferably rated 150 mv. For a temperature recorder designed for use with the fall of potential principle, an existing 50 mv shunt may be used.

The principle of the double Kelvin bridge is incorporated in a recording instrument to provide a graphic record of the temperature of a rotor. The fundamental circuit is shown in Fig. 3. The resistances shown within the outline of the instrument are of the slide wire type. Balance of the circuit is continuously maintained by automatic positioning of the two sliding connections of the galvanometer. When the galvanometer reading is zero, the resistances are in the following relation:

$$\frac{X}{R} = \frac{B}{A} = \frac{b}{a}$$

Since the reaction of the recorder is to continuously maintain the galvanometer at zero, a curve is drawn on a chart which is scaled in degrees C, representing the temperature of the rotor winding. Since the field windings are inductive, sudden changes in field current produce transient voltages in the circuit. To prevent false indications of temperature, and possible damage to the galvanometer, a capacitor is shunted across the terminals of that instrument.

In all three diagrams, a main field rheostat, a breaker, and a discharge resistor are shown. In no case are the measurements affected by the presence of such equipment in the circuit.

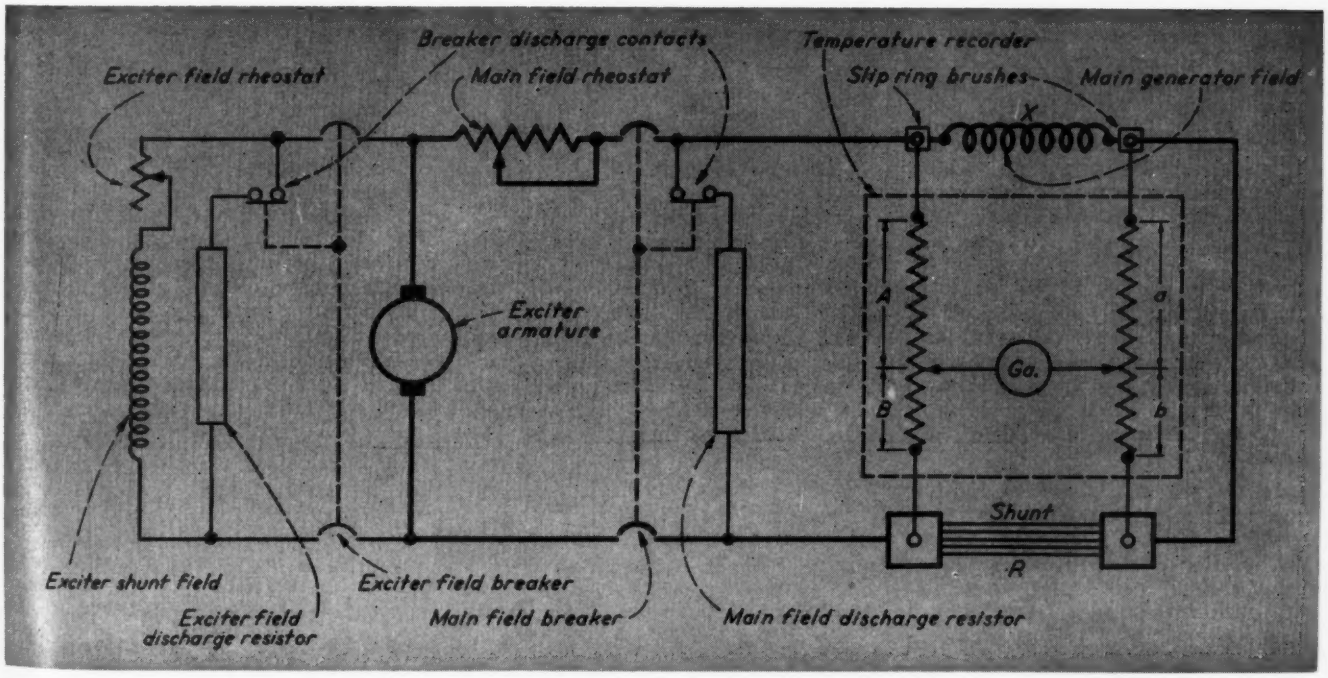
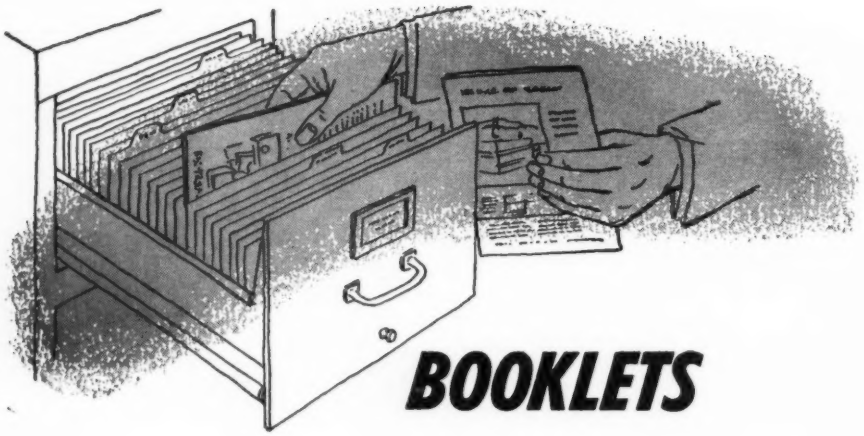


FIG. 3—BRIDGE-TYPE RECORDER USES MACHINE CIRCUITRY TO FORM BRIDGE; ADJUSTING ARMS MAINTAIN BRIDGE BALANCE. RESISTANCE VARIATIONS ARE INDICATED AS TEMPERATURE CHANGES BY ARM MOVEMENTS.



BOOKLETS

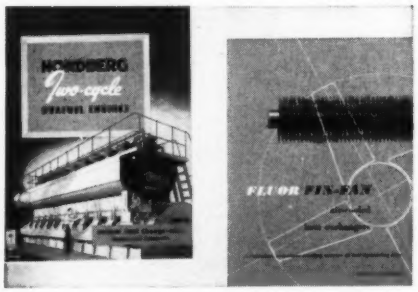
"MEN, METHODS & MACHINERY" is the title of a 44-page booklet prepared to acquaint others with the work of a company described as hydraulic land fill specialists. It reports on many well known projects, describing solutions to various difficult construction problems. Equipment includes a fleet of hydraulically self-loading and self-unloading hopper dredges, motors up to 4000 hp, 28-in. pumps capable of delivering 40,000 gpm, pile drivers, cranes, bulldozers, and auxiliary equipment. *The Construction Aggregates Corp., 33 N. LaSalle St., Chicago, Ill.*

"ALUMINUM BUILDING SHEET for Industrial Buildings" is the subject of 12-page bulletin AD-247. Advantages for siding and roofing are listed. Descriptions of fasteners, accessories, and flashing details are illustrated with engineering drawings. Tips on installation are contained in a section on how to apply the building sheet. Suggested specifications are presented. *Aluminum Company of America, 758 Alcoa Bldg., Pittsburgh 19, Pa.*

STANDARDIZED BUILDINGS are the subject of a 20-page brochure. Among the advantages for this type of construction, the brochure lists lower over-all cost, permanence, speedy erection, and greater flexibility. According to the booklet, the structures provide more usable building space, can be adapted to meet special requirements, and are designed to meet the most exacting building codes. *Luria Engineering Co., 500 Fifth Ave., New York 36.*

LAMPS for many important lighting services are tabulated in 72-page large lamp catalog. Lamps are listed both by the service to which they are put, and by types such as fluorescent, incandescent, germicidal, mercury, and ozone. In addition to listing and picturing many types of lamps, information about their construction, operation, and application is provided for the guidance of the book's users. *General Electric Lamp Div., Nela Park, Cleveland 12, Ohio. Price 70¢.*

DUAL-FUEL ENGINES are described in 16-page bulletin 202. A schematic diagram shows starting air, fuel oil, pilot oil, and gas lines. Operation, advantages, and construction are discussed. Data are presented on the pilot oil injection system, hydraulically actuated gas valves, forced feed lubrication, and positive action safety devices. *Nordberg Mfg. Co., Milwaukee 1, Wis.*



HEAT EXCHANGERS — Forced draft, air-cooled heat exchangers for a wide variety of industrial cooling and condensing applications are discussed in 12-page bulletin FF-FD-0.001. How they operate, design features, and construction are discussed. Data on heat transfer, horsepower, and space requirements are included in a discussion of applications. *The Fluor Corp., 2500 S. Atlantic Blvd., Los Angeles 22, Cal.*

ABRASIVE SURFACE CASTINGS, including safety treads, thresholds, floor plates, and elevator sills are described in 12-page bulletin AB-512. Types of surfaces and their applications are listed. Specifications are presented in drawings. Other non-slip products such as an abrasive mat, abrasive flooring compound, and abrasive paint also are described. *American Abrasive Metals Co., 460 Coit St., Irvington 11, N. J.*

MORTER CEMENT is the subject of 16-page, pocket-size bulletin AM-20M. It discusses the characteristics deemed desirable in a good masonry cement by architects, engineers, builders, and masonry contractors. Case histories are presented. *Universal Atlas Cement Co., 100 Park Ave., New York 17, N. Y.*

FIRE PROTECTION is provided by thermostat units described in 4-page folder MC-107A. Units, designed for use with alarm or release systems, are said to provide positive fire and overheat detection. In addition to explaining how the units work, the literature provides specifications for selecting the proper type for a particular application. *Fenwal, Inc., 218 Pleasant St., Ashland, Mass.*

AIR POLLUTION—Effects of weather on air pollution are discussed in detail in a 40-page publication, "The Meteorology of Air Pollution." Issued as chapter 8 of the MCA Air Pollution Abatement Manual, it discusses applications of meteorology to air pollution control engineering, fundamentals of meteorology, determination and effects of atmospheric diffusion and turbulence, stack meteorology, planning and interpreting air pollution surveys, plant site selection in relation to air pollution climatology, and methods and applications of meteorological control. *Manufacturing Chemists' Association, 246 Woodward Building, Washington 5, D. C. Price 75¢.*

LIQUID LEVEL GAGE VALVES for both tubular and flat gages are described in a set of nine data sheets. Types with regular, offset, and union connections to gage are presented. In addition to specifications, the literature contains illustrations showing cross-sections, roughing dimensions, and available connections. *Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.*

CONTROL SYSTEMS for the power industry are discussed in 6-page folder 3010. To suggest how control systems can be arranged, the bulletin presents views of actual installations

Personal copies of booklets can be obtained by writing directly to the manufacturers. Please mention this magazine. Thank you.

and discusses some of the interesting details. *Panellit, Inc., 6312 N. Broadway, Chicago 40, Ill.*

DUST CONTROL EQUIPMENT for foundries is the subject of revised 28-page brochure 1152. Latest information is presented, together with installation photos and diagrams of multi-wash collectors, fluids, and cupola collectors. *Claude B. Schneible Co., Sales Dept. 2, P. O. Box 81, North End Station, Detroit 2, Mich.*

VACUUM CLEANING SYSTEMS—Design factors for vacuum cleaning and high pressure pneumatic conveying systems are discussed in an 8-page reprint. A few of the more important topics discussed include piping layout, selection of velocities and pipe sizes, estimation of pressure drop, and selection and arrangement of the vacuum producer. The paper includes useful data, charts, and tables. *U. S. Hoffman Machinery Corp., Air Appliance Div., Attention Gen. Mgr., 105 Fourth Ave., New York 3, N. Y.*

CONTROL INSTRUMENTS for measuring and controlling numerous process variables are the subject of 60-page booklet 1530. Specifications and ratings for both electric and pneumatic controllers are presented, together with descriptions of the control action. In addition, engineering data on electrical control relays are presented. *Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Station 64, Wayne & Windrim Aves., Philadelphia 44, Pa.*

RECORDER CONTROLLERS—How to select the appropriate controller action to match requirements of a process is explained in 16-page bulletin 465. A simple recorded instrument for automatically controlling process variables such as temperatures, pressure, liquid level, and humidity is described. Construction of the unit and component parts of pneumatic control systems are discussed. Also described are indicating and electric types. *The Foxboro Co., Foxboro, Mass.*

OVER-FIRE AIR SYSTEMS and how they operate are discussed in a 4-page folder entitled "Smoke Is Wasted Fuel." Instructions on how to select the proper size are presented, together with a selection chart and a table of fan data and characteristics. The literature also explains how an automatic control using an electric eye can be used. *Canton Stoker Corp., Andrew Place, S. W., Canton 1, Ohio.*

ELECTRIC HEATERS and heating devices, in terms of application, special features, and installation, are pre-

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BOOKLETS

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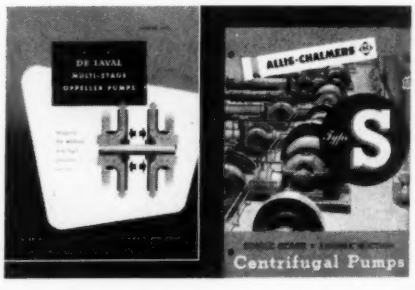
sented in 64-page catalog GEC-1005D. Indexed by process and application, the literature also gives formulas and graphs for determining power requirements and heat losses. Immersion, strip, cartridge, tubular, insertion, and fin type heaters are described, as well as melting pots, thermostats, switches, oven heaters, and induction heaters. *General Electric Co., Schenectady 5, N. Y.*

OPPOSED IMPELLER PUMP—How opposed impellers balance axial thrust is described in 12-page brochure 1502. Design features and their importance are discussed, and typical applications are listed. Sizes from 2 to 4 in., with 2 to 8 stages, are presented for capacities to 1000 gpm, pressures to 1200 psig, and temperatures to 350 F. *De Laval Steam Turbine Co., Trenton 2, N. J.*



CENTRIFUGAL PUMPS—"How to Figure Pumping Head" is a particularly useful section of 24-page bulletin 08B614B. Construction features of single-stage, double-suction centrifugal pumps are discussed, and applications are suggested. Various types of drives also are listed. In addition, the booklet contains tables of available sizes, approximate dimensions and head capacities, and tabulates friction loss of water per 100 ft of pipe. *Allis-Chalmers Manufacturing Co., 948 S. 70th St., Milwaukee, Wis.*

CENTRIFUGAL PUMPS for water, condensate, solvents, and corrosive solutions are described in 4-page folder WQ-214. A cut-away view points out the principal design features and advantages. Dimensions and standard specifications are tabulated. *Warren Steam Pump Co., Inc., Warren, Mass.*

MULTI-STAGE PUMPS for supplying, circulating, and boosting water and process liquids, are described in 12-page brochure B-1400. Specifications are tabulated, and construction is described for two, three, four, and five-stage split-case units. Capacities are listed to 3000 gpm. Heads are to 1550 ft. *Peerless Pump Div., Food Machinery & Chemical Corp., 301 West Ave. 26, Los Angeles 31, Cal.*

OIL BURNERS, combination gas and oil burners, oil pumps, and accessories are described in 20-page booklet 3048. Subjects such as how to select a burner, engineering and manufacturing factors, construction features, principles of operation, typical installations, basic firing operation, automatic operation, and use of panel or control boards are presented. *Petro, 3170 W. 106th St., Cleveland 11, Ohio.*

HERRINGBONE GEAR DRIVES are the subject of 40-page booklet 2519. Tables list ratings, overhung loads, and specifications. Construction, applications, and advantages of single, double, and triple reduction enclosed drives are presented. An engineering data section tells how to select the proper drive. Units are listed in standard ratios from 2.84:1 to 326:1. Capacities range from 0.4 to 2480 hp, and output shaft speeds range from 2.2 to 623 rpm. *Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.*

"MOTOR AND GENERATOR REFERENCE BOOK," 50-page booklet 51R7933, presents information to assist in the selection of motive power to handle most industrial applications. Considerable data and information of value are presented and supplemented with illustrations. The booklet is reprinted from the 1952 edition of "Lincoln's Industrial-Commercial Electrical Reference." *Allis-Chalmers Manufacturing Co., 948 S. 70th St., Milwaukee, Wis.*

MOTOR CONTROL apparatus, including starters and accessories, is discussed in "Quality Line of Motor Controls for All Industries," a 28-page booklet. Construction, advantages, and applications are listed. *Allen-Bradley Co., Milwaukee, Wis.*

POWER CONVERSION UNITS — Features, advantages, and descriptions for metallic rectifier power conversion units are presented in 8-page bulletin GEA-5658B. Performance, circuits, and ratings are listed for units from 125 to 250 v d-c. Information also is provided to aid in preparing contract specifications entailing d-c power supplies and exciters. Drawings show dimensions. *General Electric Co., Schenectady 5, N. Y.*

ELECTRICAL EQUIPMENT for woolen and worsted mills is the subject of 40-page booklet B4798. Starting with the opening and picking rooms and going through the mill to the finishing department, this booklet discusses types of equipment available, applications, and special design characteristics of each. Among apparatus so appraised are motors,

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BOOKLETS —Starts on page 74

controls, and gearmotors. Also discussed are the design and application of special drives for major operations. A ready-reference drive application chart provides specifications for the major cases discussed. *Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.*

PACKAGE AUTOMATIC BOILERS are the subject of 12-page bulletin 1218. A cut-away view shows design and component parts of the unit. Performance, advantages, and types of equipment are discussed. Units are equipped with air atomizing oil and free-mix gas burners, which can be quickly converted from oil to gas or from gas to oil without additional piping or wiring. Ratings from 15 to 500 bhp are listed. *Orr & Sembower, Inc., Morgantown Rd., Reading, Pa.*

PIPE INSULATION—Described in 8-page bulletin IN6.A5 is a new wrap-around insulation for pipes of all sizes. It is a flexible-type insulation that may be applied in any thickness by wrapping layers until desired depth is reached. According to the booklet, it is adaptable to valves, fittings, and irregular pipes, as well as to straight pipes with temperatures ranging from sub-zero to 600 F. In addition to describing the advantages, the booklet presents application data and details. *Owens-Corning Fiberglas Corp., Toledo 1, Ohio.*

REGULATING VALVES for controlling flow of gases and liquids by means of floats, master regulators, or thermostats, are described in 12-page bulletin S-22-CA. Advantages, specifications, and construction are presented for diaphragm-operated, spring opening and spring closing regulating valves, pressure controllers, air locks, valve positioners, and selector panels. *The Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.*

MASS SPECTROMETER—Announcement of a new mass spectrometer designed primarily to monitor and control continuous processes in chemical plants and oil refineries, is made in 4-page folder CEC-1824. In addition to specifications, subjects such as how it operates and how it is used for process monitoring and control are discussed. *Consolidated Engineering Corp., Chemical Instrument Application Service, 300 N. Sierra Madre Villa, Pasadena 15, Cal.*

SPRAY-ATOMIZING DEAERATORS for removing corrosive gases from boiler feedwater systems on high and low pressure steam boilers and evaporators are described in 4-page folder 400. In addition to explaining how the units operate, design features, construction, and applications are described. *American Water Softener Co., Inc., Fourth & Lehigh Aves., Philadelphia 33, Pa.*

UNDERGROUND WATER—Information is available to those interested in securing data on sources of underground water or subterranean earth structure. This information is based upon many deep well installations covering the continental United States. Write giving details to *F. Dunn, Worthington Corp., Succasunna, N. J.*

"NICKEL — MONEL — INCONEL — Their Contribution to Chemical Engineering," a 48-page booklet, has been published to serve as a handbook of information on these three alloys. Mechanical properties are listed in tables accompanying discussions of each alloy and its applications. In addition, the booklet outlines the many factors, other than corrosion resistance, which must be considered when selecting an alloy for any particular application. *The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.*

Consulting Engineers' Calendar

Date	Sponsor	Event	Location
Apr. 20-22	American Management Association	National Packaging Conference	Navy Pier Chicago, Ill.
Apr. 21	Association of Consulting Chemists and Chemical Engineers	Symposium	Belmont Plaza Hotel New York, N. Y.
Apr. 22	American Institute of Electrical Engineers	Southern District Meeting	Louisville, Ky.
Apr. 24-25	Society for the Advancement of Management	7th Annual Time-Study and Management Conference	Statler Hotel New York, N. Y.
Apr. 26-29	American Institute of Chemical Engineers—Chemical Institute of Canada	Joint Meeting	Royal York Hotel Toronto, Ont., Canada
Apr. 29-May 1	American Institute of Electrical Engineers	Northeastern District Meeting	Sheraton Plaza Hotel Boston, Mass.
May 4-6	Compressed Air and Gas Institute	Convention	King & Prince Hotel St. Simons Island, Ga.
May 7-8	Society of Naval Architects and Marine Engineers	Spring Meeting	Statler Hotel Boston, Mass.
May 9-15	Society of the Plastics Industry	Annual Meeting	Cruise to Bermuda
May 10-15	American Water Works Assn.	73rd Annual Conference	Grand Rapids, Mich.
May 11-13	Heat Exchange Institute	Convention	The Greenbrier White Sulphur Springs, W. Va.
May 11-15	National Fire Protection Association	Annual Meeting	Edgewater Beach Chicago, Ill.
May 12-13	American Institute of Chemists	Annual Meeting	Philadelphia, Pa.
May 14-23	International Petroleum Exposition		Tulsa, Okla.
May 18-19	Association of Iron and Steel Engineers	Spring Conference	Statler Hotel Buffalo, N. Y.
May 18-20	American Management Association	Insurance Conference	Hotel Statler New York, N. Y.
May 18-22	Materials Handling Exposition	5th National Show	Convention Hall Philadelphia, Pa.
May 20-21	Armed Forces Chemical Association	Annual Meeting	Waldorf-Astoria New York, N. Y.
May 20-22	Engineering Institute of Canada	Annual Meeting	Nova Scotian Hotel Halifax, N. S., Can.
May 24-28	American Society of Mechanical Engineers	Oil and Gas Power Division	Hotel Schroeder Milwaukee, Wisc.
May 26-27	American Institute of Electrical Engineers	Electric Heating Conference	Detroit, Mich.
June 1-4	Edison Electric Institute	21st Annual Convention	Atlantic City, N. J.
June 28-July 2	American Society of Mechanical Engineers	Semi-annual Meeting	Hotel Statler Los Angeles, Calif.

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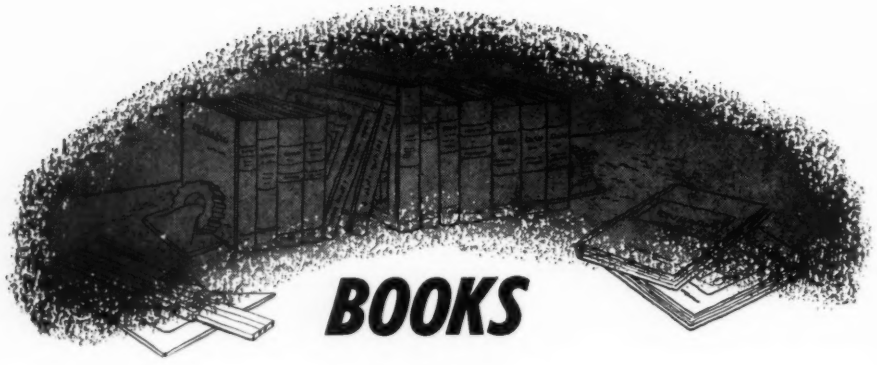

BOOKS

TO ORDER BOOKS

As a readers' service, CONSULTING ENGINEER will order reviewed books or any other technical volumes you need. In ordering books, give title, author, and publisher and enclose check or request books COD. We will also suggest titles of books on any technical subject and order for you at regular publishers' prices.

NON-FERROUS PHYSICAL METALLURGY, by Robert J. Raudebaugh, Pitman Publishing Corporation, 334 pages, $6.50.

Reviewed by
Arthur F. MacConochie
Head of the Department of Mechanical Engineering, University of Virginia

Perhaps in no phase of the vast and expanding realm of engineering science is there better reason for a new text than metallurgy, especially non-ferrous metallurgy. Time was when the extent of our knowledge of the entire field could have been readily compassed within the covers of a modest volume. But the leisurely pace of the ages of bronze and iron, even of steel itself, has no counterpart in the breathless rush of this alloy age in which we are involved.

The author of this book has done a commendable job. With clarity and brevity he covers aluminum, magnesium, copper, nickel, cadmium, lead, tin, zinc, silver, gold, platinum, berylium, cobalt, molybdenum, tantalum, and among the last but not least to which reference is made, is the new "wonder metal" titanium. With admirable skill he interweaves the scientific with the practical giving us, for example, the electron configuration for aluminum, the equilibrium systems of its alloys, and metallographic techniques for aluminum alloys. Further, he treats such important considerations for the engineer as melting, fluxing and degassing, casting, rolling, forging, and extrusion..

In similar fashion the other metals are treated with a wealth of supporting references in the bibliography at the end of each chapter. Such matters of importance to production as annealing and heat treatment, machining, riveting, and the like are not forgotten. Can magnesium alloys be welded? Here is the clear and explicit answer. "Magnesium alloys are not welded to other metals. Even though weldments could possibly be made, the relatively strong electro-positive character of magnesium-base materials induces corrosion. . . . .The joining of two magnesium alloy pieces may be accomplished by torch, gas, shielded-arc, resistance (seam or spot) welding."

It is customary to find some fault of omission or commission on the part of the author whose work has been submitted to the critical eye of another in his field; but this reviewer has been back and forth through this text without being able to justify any title to superior wisdom. Even the wealth of excellent illustrations evokes nothing but praise for the technical skill manifest in their reproduction. Amongst these is an electron micrograph of polished and etched carbonyl iron powder particles in the chapter on powder metallurgy—a most interesting exhibit.

ELECTRICAL CONTROL SYSTEMS, by Richard W. Jones, 3rd edition, John Wiley and Sons, Inc., 511 pages, $7.75.

Reviewed by
H. G. Gossman
Transmission and Distribution Standards Engineer
The Dayton Power and Light Co.

This book, first published in 1950 and already in its third edition, resulted from a course designed for senior electrical students already well grounded in basic engineering mathematics and electrical theory. The main purpose of the book is to more fully acquaint them with the many types of electrical controls, most of which they would not run across in their laboratory work.

This is the type of text which a student might well carry with him into his professional life. It correlates the many types of electrical controls. The author outlines each type of control and with formulas, sketches, and graphs, explains its operation.

After reviewing the characteristics of the many motor types, the author swings into control devices and, with block diagrams, outlines their application. The control devices range from the well known electro-magnetic contact - making devices to the latest gaseous and electronic devices which almost think for themselves and are capable of controlling operations beyond the power of manual design.

There are chapters on magnetic amplifiers, counter circuits, and motor braking which should suggest many practical applications to the consulting engineer. The book is worth its cost in that it probably contains just the control idea that would escape the practical consultant.

The author has provided an adequate bibliography for those in search of more detailed information on the subjects covered in the text.

Reviewed by
E. H. MacDonald
Industrial Economist
Richmond, Virginia

HOW YOU REALLY EARN YOUR LIVING —EVERY MAN'S GUIDE TO AMERICAN ECONOMICS, by Lewis H. Haney Prentice-Hall Publishing Co., 282 pages, $3.00.

There are a large number of businessmen who know that Dr. Haney knows how to write for the businessman since he is the author of a column in the widely-read *Bulletin of the National Association of Purchasing Agents.* This ability serves him well in this volume since it was written for the businessman as well as for customers and employees. The book is a primer of economics, and as such it is one of hundreds written for the same purpose. But where many have failed in the objective of imparting the elementary economic facts of life, Dr. Haney can be credited with a "mission accomplished."

In a sense, the book is written in the form of a dialogue with Dr. Haney taking the parts of both interlocutor and respondent. He asks 461 questions, the answers to which spell out in non-technical language the elementary principles of our economic life. The questions are basic, shirt-sleeved ones that pop up every time anyone tries to figure out what is going on in the business world. Being basic, they are also timely. For example, he asks, and answers, "What is the idea of a 'guaranteed annual wage'?"—"Why don't money wages and salaries seem high enough?"—"How much taxation is necessary?"

The reader will not end up at the

last page as an economist, but he will have taken an important step toward a better understanding of his economic environment—and it is said that the longest journey begins with a single step.

INVESTMENT CASTING FOR DESIGN ENGINEERS, by Rawson L. Wood and Dadidlee von Ludwig, Reinhold Publishing Company, 479 pages, $10.00.

Reviewed by
Arthur Roberts, Jr.
Chief Engineer
Lynchburg Foundry Company

While I have been in the foundry business for many years, I am all too unfamiliar with the subject of investment castings. This volume, however, is written in words that any layman can understand, and the contents are so arranged that one can go from the simpler information to the more technical without getting lost.

Illustrations and charts fit nicely with the text material and are of considerable assistance to the reader.

Certainly, this book is a very good description of the advantages and limitations of the investment casting processes now in current commercial use. All of the more recent techniques are described and a comprehensive tabulation of the many high temperature and corrosion resistant alloys of steel, nickel, and cobalt are offered for the first time, to my knowledge.

ALSO AVAILABLE

THE FEDERAL DEBT—STRUCTURE AND IMPACT, by Charles C. Abbott, The Twentieth Century Fund, 278 pages, $4.00. This book contains the policy recommendations of the Twentieth Century Fund's Committee on the Federal Debt.

CONSTRUCTION AND APPLICATIONS OF CONFORMAL MAPS, National Bureau of Standards, 280 pages, $2.25. Contains reports on theory and application of conformal maps prepared by scientists from universities and industries and presented at a symposium held at NBS Institute for Numercial Analysis, Los Angeles.

CASE STUDIES IN COMMERCIAL CHEMICAL DEVELOPMENT, by John E. Ulmann, Chemonomics, Inc., 134 pages, $5.00. A collection of case studies presented as a description of the methods by which a large variety of products from the chemical process industries have been developed, tested, and finally placed on the market. Case histories cover such chemicals as aerosols, toxaphene, krilium, orlon, vicara, TB drug, glyoxal, and others. Concrete examples of 37 products as handled by 64 process companies are given.

FUNDAMENTAL RESEARCH IN ADMINISTRATION, Carnegie Press, $2.00. This book reports the discussion of an informal round table conference in which business, industrial, education, research, and communication leaders participated during the dedication of the nation's first graduate school of industrial administration at Carnegie Tech.

RADIO FREQUENCY POWER MEASUREMENTS, by Ronald A. Schrack, National Bureau of Standards Circular 536, 16 pages, 15¢. This circular presents a survey of the methods currently in use for the measurement of radio frequency power. It gives a brief discussion of the theoretical background, practical limitations and advantages of these methods.

INDUSTRIAL PLANT LOCATION—ITS APPLICATION TO ZINC SMELTING, by Carl Hayden Cotterill, 155 pages, $5.00. This book presents an integrated description of the zinc industry in the United States and demonstrates a scientific approach to the regional location of industrial plants considering the usual factors of raw material, labor, power, fuel, market area transportation, capital sources, laws, taxes, and technological requirements in their geographical variations.

Industrial Films

"LIGHTNING MASTERS", sound and color, 30 minutes, General Electric Company, Schenectady 5, N. Y. This new film depicts the phenomena of natural lightning and tells the story of lightning research and development of modern protective equipment. The film cites the important advances made over three decades during which lightning has been resolved from a mysterious force of nature to quantitative engineering facts. It tells about the efficiency in economics of modern methods of protecting power systems from lightning—how lightning arrestors, costing less than two per cent of the apparatus they protect, safeguard the large investment in power equipment.

"THE SKY IS THE ROOF", color and sound. 12 minutes, Allis-Chalmers Manufacturing Company, General Machinery Division, Milwaukee 1, Wis. A brief background history of the development of the weather-protected motor is presented in this film. It shows storm tests to which these motors are subjected. The movie shows how such a motor, while running at normal speed and voltage, can be deluged with water and buffeted by winds, yet no moisture can be detected on the windings.

consulting engineer

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